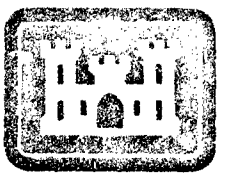

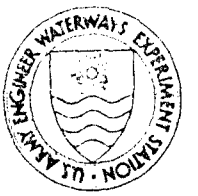

EVALUATION OF SHELL CHEMICAL COMPANY'S GROUND-WATER DBCP CONTROL SYSTEM AT ROCKY MOUNTAIN ARSENAL FOR THE PERIOD JANUARY 1984 THRU SEPTEMBER 1984

by
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THIS STUDY IS PART OF A CONTINUING ASSESSMENT OF THE PERFORMANCE OF THE IRONDALE DBCP CONTROL SYSTEM IN PREVENTING THE OFF-POST MIGRATION OF CONTAMINATED GROUND WATER. THE INVESTIGATION INCLUDED THE COLLECTION AND EVALUATION OF DATA FROM MONITORING WELLS, THE TREATMENT SYSTEM, AND THE SACWSD PRODUCTION WELLS. THE DATA COLLECTED WERE USED TO DEVELOP WATER TABLE MAPS, GROUND WATER PROFILES, DBCP CONCENTRATION MAPS, AND SUMMARIES OF THE TOTAL VOLUME OF WATER PUMPED BY THE CONTROL SYSTEM AND BY THE SACWSD WELLS. THE MAPS AND SUMMARIES DOCUMENT THE OPERATION AND EFFECTIVENESS OF THE BOUNDARY SYSTEM DURING 1984.

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PREFACE

This study was conducted during the period 1 January 1984 to 30 September 1984 as a cooperative effort by personnel from the USAE Waterways Experiment Station (WES), Rocky Mountain Arsenal (RMA), and Shell Chemical Company (SCC). Funding for participation by WES was provided by the US Army Armament Munitions and Chemical Command, Rock Island, IL, via Intra-Army order for reimbursable services No. MI-3-85558-MI-3V. Project coordination was provided by Messrs. E. Berry (RMA), D. Thompson (WES), and E. Swift (SCC).

This study is part of a continuing assessment of the performance of the Irondale DBCP Control System at RMA. Previous work has been reported in two reports. The first report entitled "Evaluation of Shell Chemical Company's Ground-water DBCP Control System, Rocky Mountain Arsenal, Colorado, Final Report Phase I," by May and Whitten details system monitoring conducted during FY 82. The second report entitled "Evaluation of Shell Chemical Company's Ground-water DBCP Control System, Rocky Mountain Arsenal, Colorado, Final Report Phase II," by Whitten and May consolidates the system monitoring data collected over FY 82 and FY 83.

This report was prepared by Mr. D. Thompson, Water Supply and Waste Treatment Group (WSWTG), Environmental Engineering Division (EED), Environmental Laboratory (EL), and Mr. C. Whitten, Engineering Geology Application Group (EGAG), Engineering Geology and Rock Mechanics Division (EGRMD), Geotechnical Laboratory (GL). The report was prepared under the direct supervision of Mr. N. Francinques, Chief, WSWTG, and Mr. J. Shamburger, Chief, EGAG, and the general supervision of Mr. A. Green Chief, EED, and Mr. D. Banks, Chief EGRMD. Dr. J. Harrison was Chief, EL and Dr. W. Murcuson, III, was Chief, GL during the study.

The authors wish to acknowledge the support and assistance of the following people during the study: Mr. E. Berry (RMA) for overall project direction; Mr. B. Anderson and Dr. W. Trautman (RMA) for their assistance in collecting water level elevation data; Messrs. J. Dildine and W. Farrell (WES) for their assistance in collecting water level elevation data; and Mr. E. Swift (SCC)

for his assistance in providing the analytical data for the monitoring wells and the operational data for the control system.

The Commander and Director of WES during this study was COL Tilford C. Creel and the Technical Director was Mr. F. R. Brown.

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EVALUATION OF SHELL CHEMICAL COMPANY'S GROUND-WATER DBCP CONTROL SYSTEM AT ROCKY MOUNTAIN ARSENAL FOR THE PERIOD JANUARY 1984 THRU SEPTEMBER 1984

PART I: INTRODUCTION

Background

1. In March 1980, Nemagon (Dibromochloropropane-DBCP) was discovered in some of the water wells producing from the alluvial aquifer in the Irondale community, which is located along the northwest boundary of Rocky Mountain Arsenal (RMA). The RMA and Shell Chemical Company (SCC) initiated a coordinated program to identify the source and define the migration route of the DBCP contaminated ground water.

2. Chemical and water level data from the limited number of monitoring wells existing at that time showed that DBCP contaminated ground water was moving off RMA at the northwest corner of Section 33 and that the ground-water contamination on RMA extended northwest from the area of a railcar storage area in Section 3 (see Figure 1). DBCP was the only contaminant detected in the ground water. The data collected indicated that the railcar storage area was the likely source of the contamination although no spills or leaks in this area have been documented.

3. In order to eliminate the migration of contaminated ground water from the Arsenal, the SCC constructed a control system, known as the Irondale DBCP Control System, in the northwest corner of Section 33. The system was designed to dewater the alluvial aquifer, remove the contaminants from the water, and inject the water back into the alluvial aquifer. The control system went into operation on 10 December 1981.

Irondale DBCP Control System

4. The control system is composed of two rows of extraction wells and one row of recharge wells. As originally constructed (Figure 2), rows 1 and 2 of the extraction wells consisted of 15 and 18 wells, respectively, with the wells spaced 100 ft apart within each row. Fourteen recharge wells were constructed in the original system also on 100 ft centers. Starting in August 1983, a

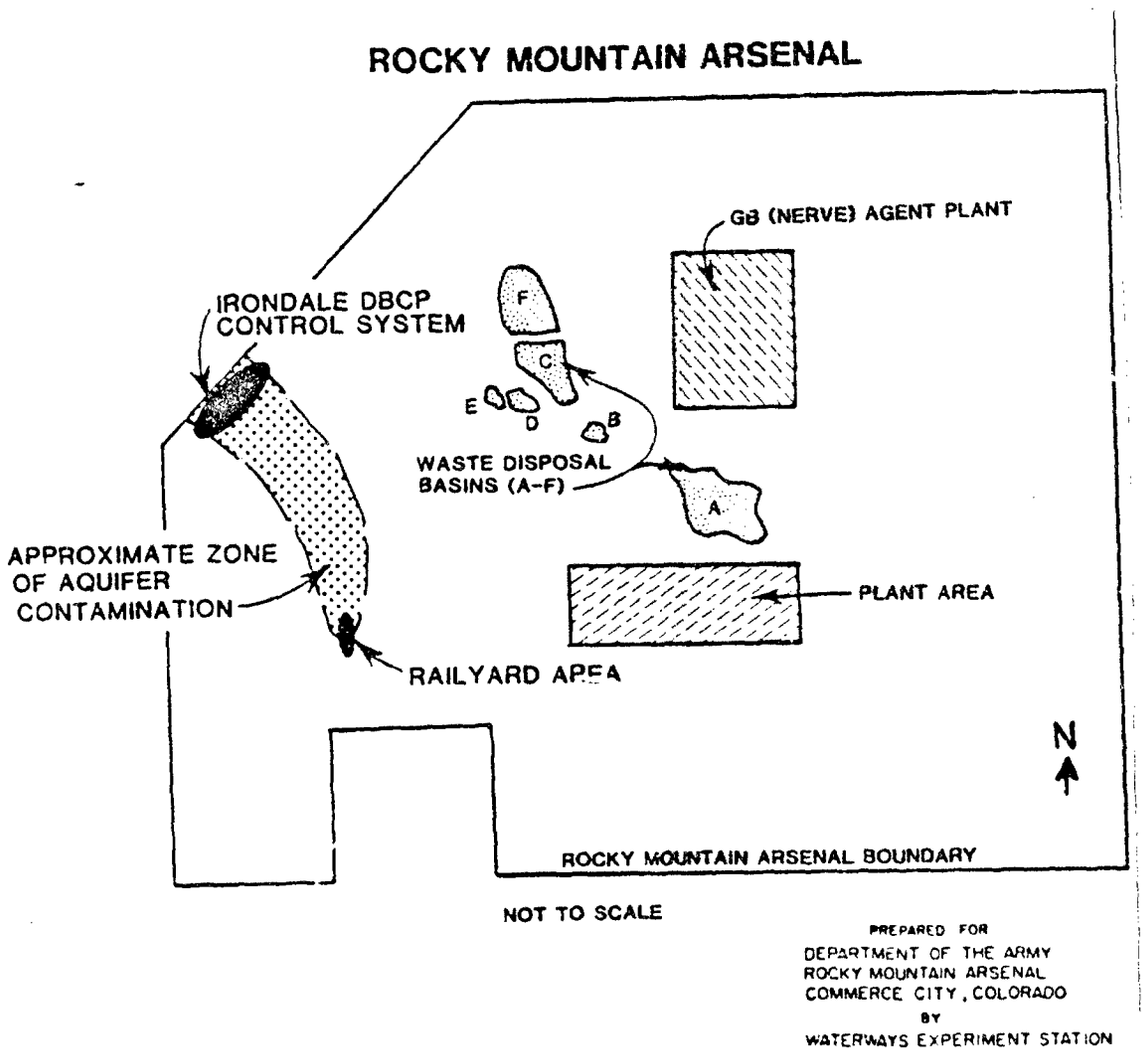


Figure 1. Approximate zone of aquifer contamination.

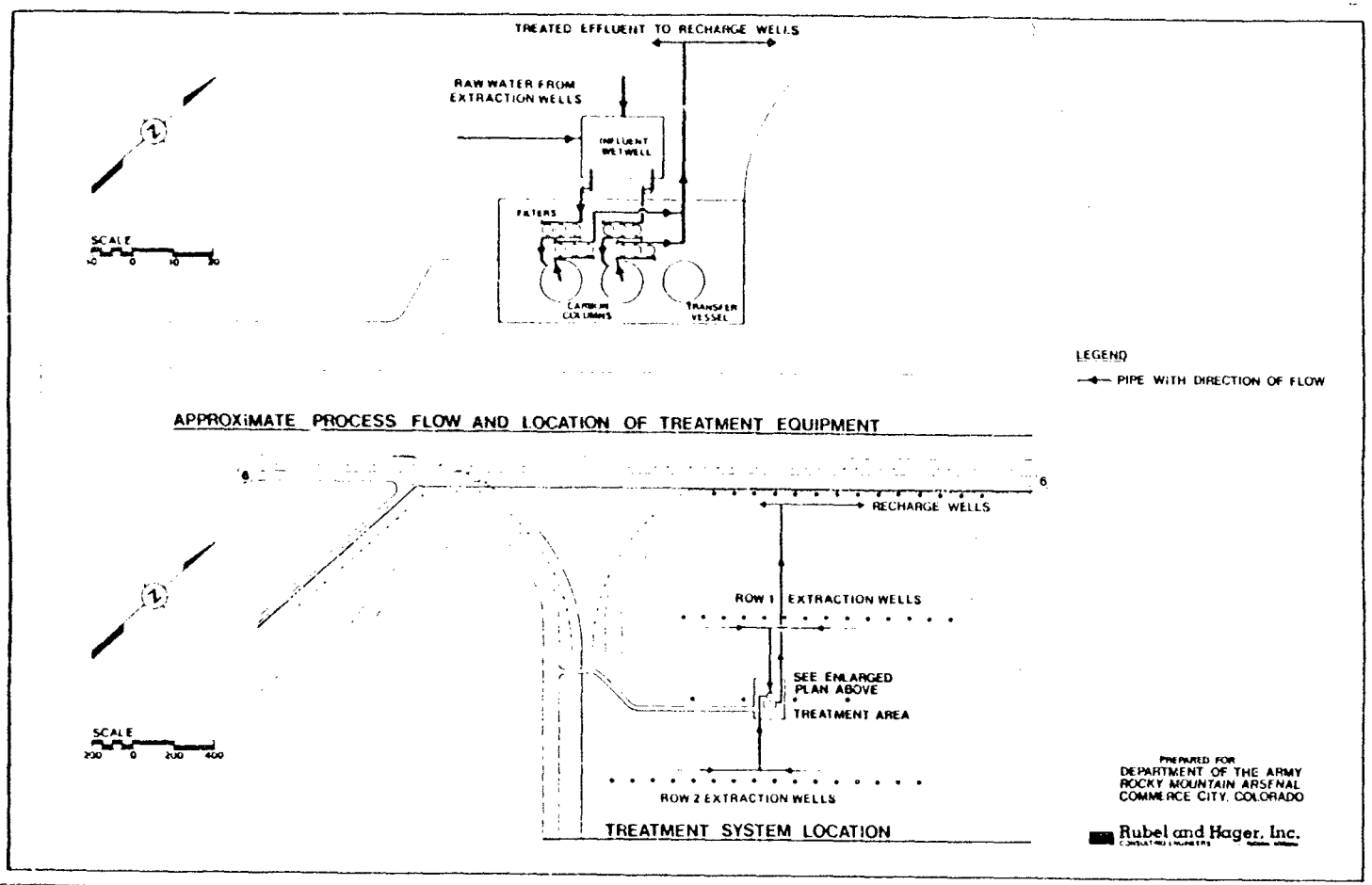


Figure 2. Plan view of the treatment system (after Rubel and Hager). See plate 1 for well numbers.

number of the extraction wells were reworked with some pumps being replaced. The resulting increase in ground-water flow exceeded the capacity of the recharge wells and as a result, treated water was surface discharged northeast of the control system during the period November 1983 thru January 1984. Although the recharge wells were reworked, their original capacity could not be achieved. In order to increase recharge capacity, six additional recharge wells were constructed in February 1984. These new wells were placed in line with the existing row or recharge wells on 100 ft centers, starting midpoint between recharge wells 4 and 5, and extending to the southwest. In addition, during May 1984, five extraction wells (three on row 2 and two on row 1), two recharge wells, and one monitoring well were added to the system. The final layout of the wells in the system is illustrated in Plate 1. Row 1 of the extraction wells is 800 ft northwest of row 2, and the row of recharge wells is 600 ft northwest of the row 1 extraction wells. Construction details of the extraction and recharge wells are shown in Figures 3 and 4, respectively.

5. The treatment plant is located between the two rows of extraction wells (Figure 2). The design flow rate of the treatment plant is 1400 gpm. The extraction wells pump the contaminated ground water to the influent well. The water is then distributed to two separate 700 gpm treatment trains consisting of prefilters, a carbon adsorber, postfilters, and bag-type, guard filters. The water is first pumped through the prefilters to remove any suspended solids. Next, the water flows into the activated carbon columns where the contact time is 15 minutes at the designed flow rate. The water then flows to the postfilters and bag-type, guard filters to remove carbon fines and through the distribution system to the recharge wells. A flowmeter records the volume of water treated by each of the treatment trains.

6. The control system also contains a number of monitoring wells (see Plate 1). Some of the monitoring wells were constructed by RMA prior to the construction of the control system. These wells typically consist of a 2-in PVC casing with a 2-in PVC well screen placed in the saturated zone of the alluvium. Some of these wells are placed in clusters, where the saturated thickness of the alluvial aquifer is screened by a set of wells screened at different depths. The monitoring wells, identified by a "S" and those included in the 33-500 series, were constructed by the SCC. Construction details of

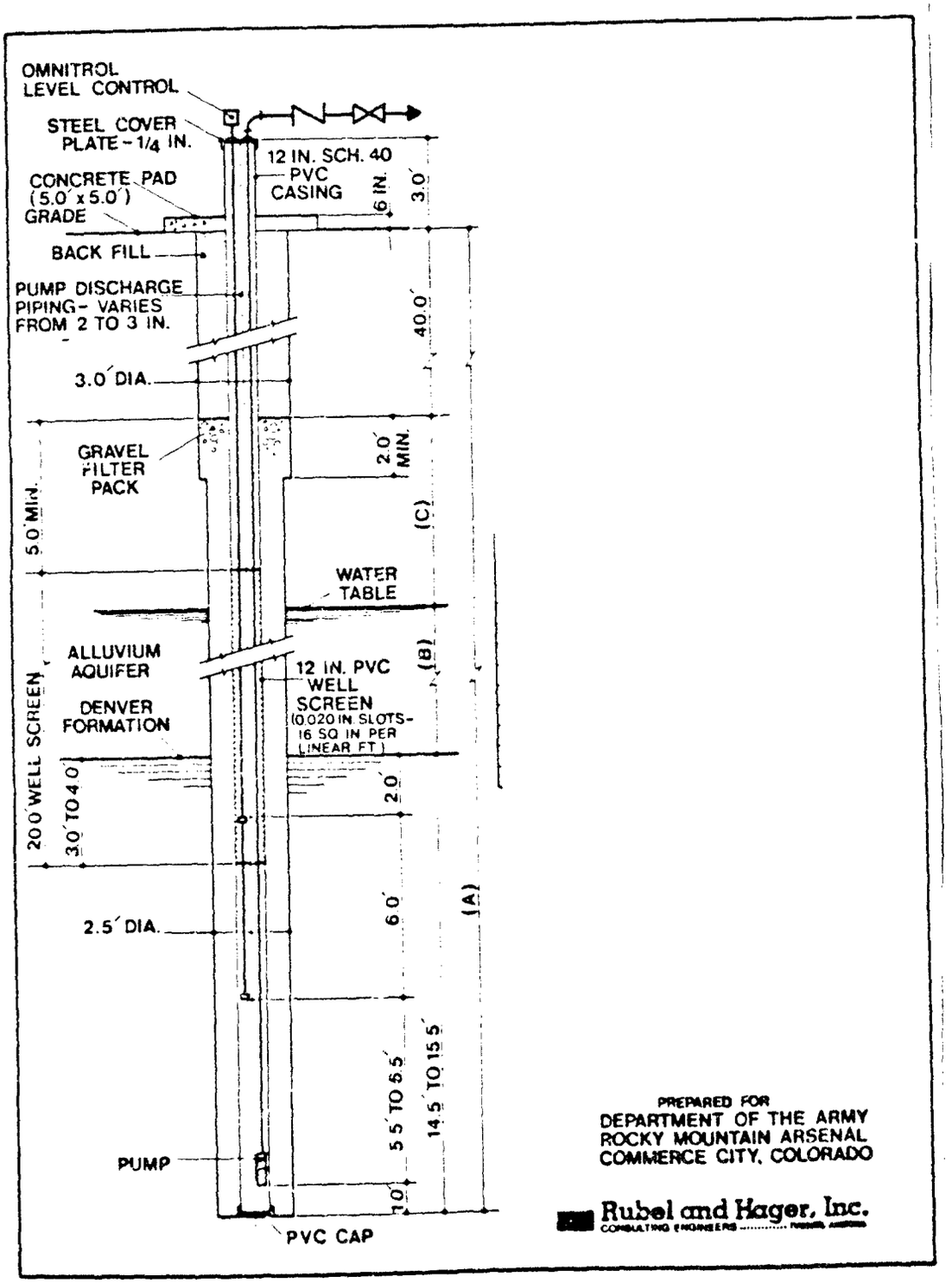


Figure 3. Extraction well design (after Rubel and Hager).

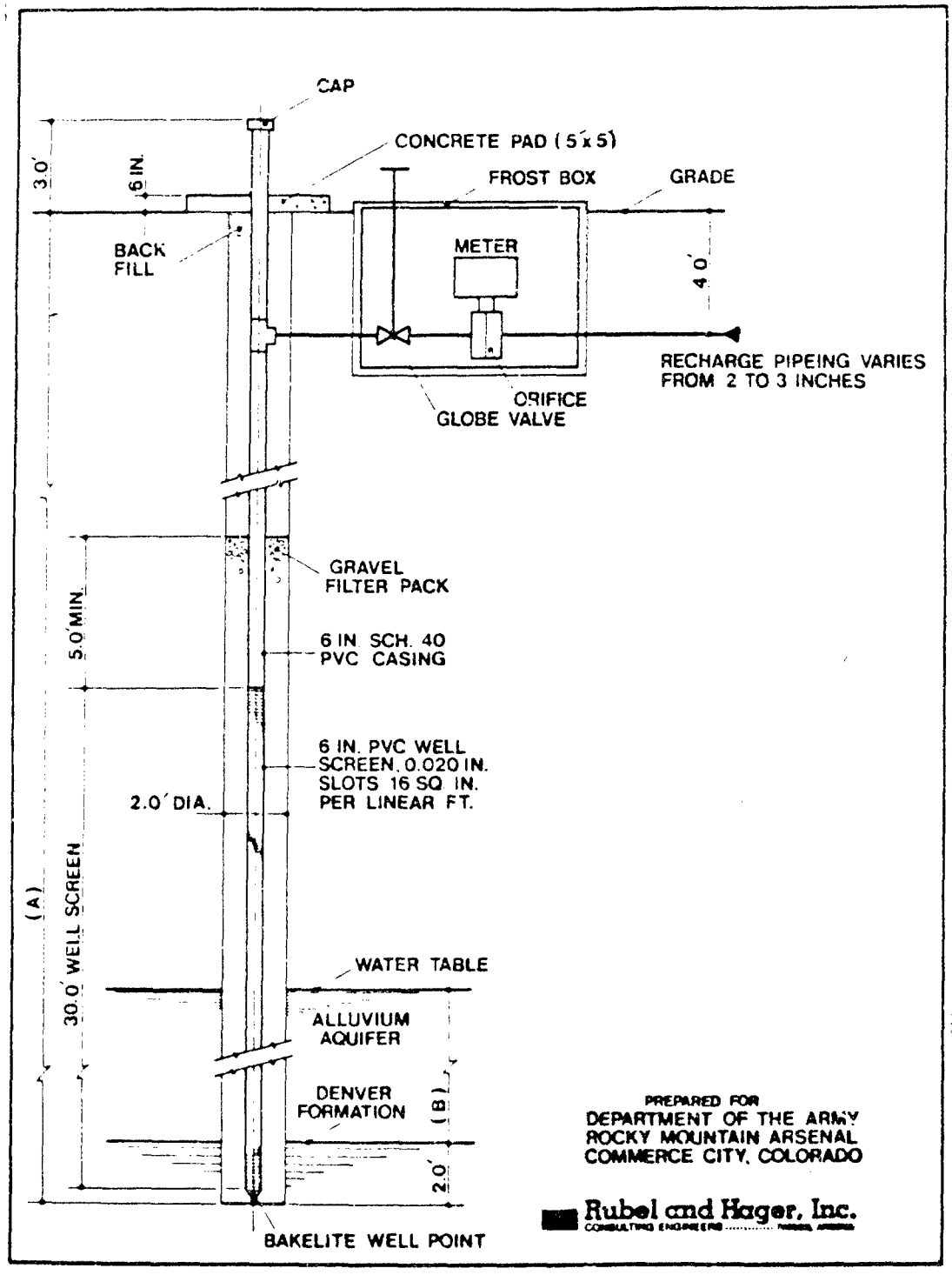


Figure 4. Recharge well design (after Rubel and Hager).

these monitoring wells are shown in Figure 5. During the summer of 1984, the Army constructed a series of multi-level-screened wells along 7th Avenue which are identified by the "RSD" prefix on Plate 1. These wells were constructed using 2-in PVC well screen and casing (2). Private wells in the Irondale community (series "C" and "M" wells on Plate 1) are also sampled for DBCP analysis.

South Adams County Water and
Sanitation District municipal wells

7. The South Adams County Water and Sanitation District (SACWSD) has four municipal wells located at two sites (Sites 6 and 7) within one-half mile of the control system. Wells 5 and 17 (Site 7) are at 77th and Quebec Street, which is about 1000 ft west of well 33-12. Well 5 is a 48-in.-diam well equipped with 100 and 200 horsepower (hp) (1000 and 2400 gpm, respectively) electric pumps. Well 17 is about 50 ft from well 5 and is equipped with one pump. Wells 2 and 3 (Site 6) are at 77th and Pontiac Street, which is about one-fourth mile west of Site 7. Wells 2 and 3 are 109 ft deep and wells 5 and 17 are 119 ft deep. All four wells pump water from the alluvial aquifer. Wells 5 and 17 pump water from the thick alluvial channel (Plate 2) that extends into RMA just south of the control system. These wells are important because of their potential influence on the ground-water flow in the area of the control system. It should be noted that these wells are operated on an intermittent basis with the majority of the production occurring the summer months.

Geology

8. The geologic units of concern in this study are the Denver formation and the alluvium. The Denver formation underlying RMA is composed of interbedded shale, claystone, siltstone, sand, and sandstone with some low-grade coal, lignite, and carbonaceous shale. The water-bearing zones within the Denver formation are generally composed of weakly cemented sandstones or compact fine- to medium-grained sands. The sand or sandstone layers are commonly lens-shaped, range in thickness from several inches to as much as 60 ft, and grade laterally and vertically into silts and clays. Elevations of the top of the Denver formation are presented on Plate 2. This map includes the new data obtained from the wells constructed along 7th Avenue during the summer of 1984 (2).

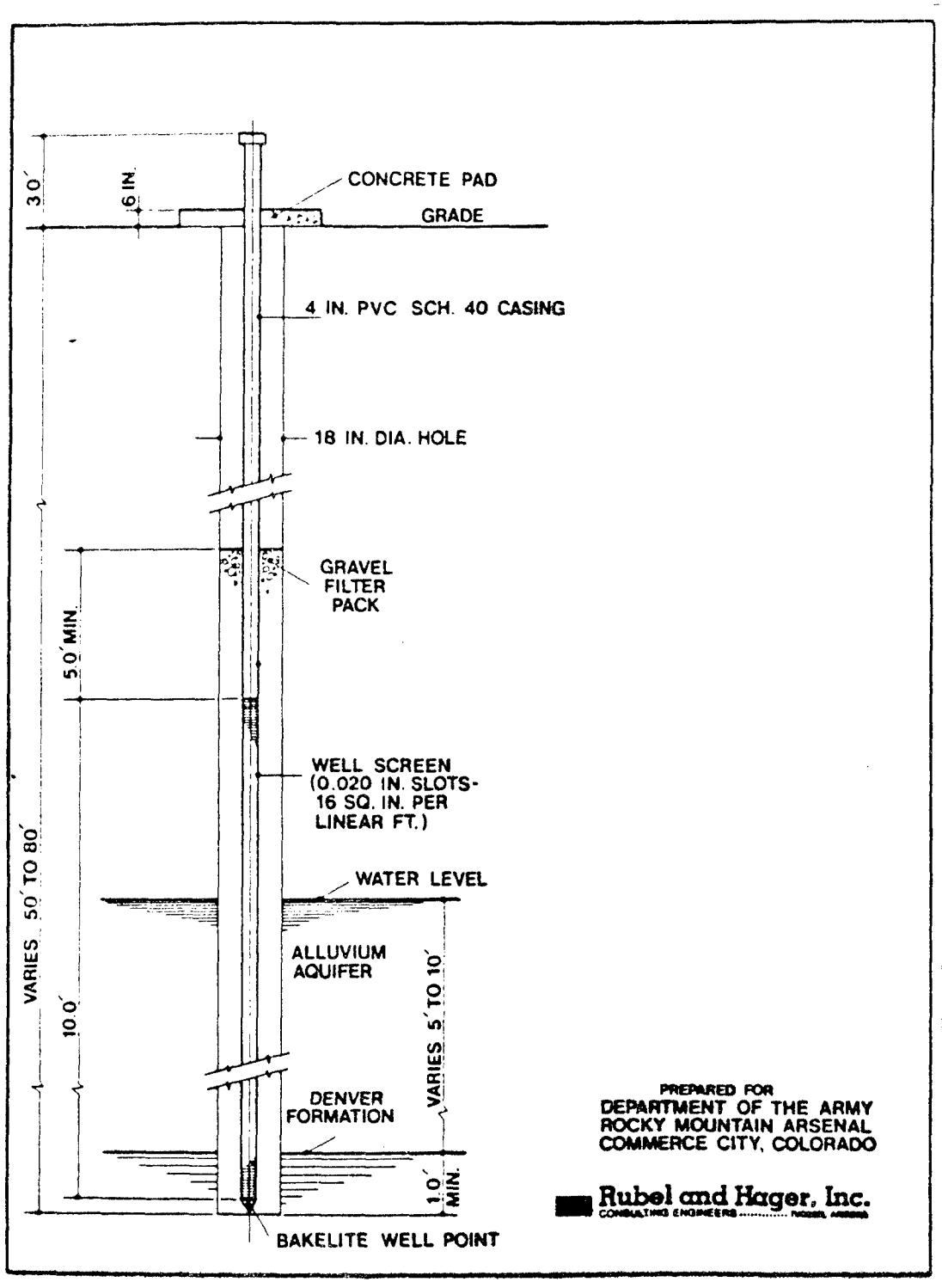


Figure 5. Monitoring well design (after Rubel and Hager)

9. Overlying the Denver formation is the alluvium which is composed of clays, silts, sands, and gravels. The water table (top of alluvial aquifer) varies from 30 to 60 ft below the ground surface in the general area of the control system. The saturated thickness of the alluvium varies from less than 10 ft at the higher elevations of the Denver formation subcrops to about 70 ft in the alluvial channel south of the control system (Plate 2). Typically, the permeability in the alluvium is three orders of magnitude larger than the Denver sands.

Monitoring program

10. As part of the ongoing operation of the control system, RMA and SCC have conducted a cooperative monitoring program in order to evaluate the effectiveness of the system. The USAE Waterways Experiment Station (WES) was requested by RMA to participate in this program. During the period December 1981 thru September 1983, WES, RMA, and SCC conducted quarterly monitoring of water levels and water quality using the available monitoring wells. The data collected were evaluated and the results presented in a report published by WES in December 1983 (3). Subsequently, RMA requested that WES continue to participate in the program and prepare a summary, year-end report for FY84.

Purpose and Scope

11. The purpose of the FY84 investigation was to continue the monitoring and evaluation program on the Irondale DBCP Control System to determine the effectiveness of the system in preventing the off-post migration of contaminated ground water. The investigation included the collection and evaluation of data from monitoring wells, the treatment system, and the SACWSD production wells over the period January 1984 thru September 1984. The data collected were used to develop water table elevation maps, ground-water profiles, DBCP concentration maps, and summaries of the total volumes of water pumped by the control system and by the SACWSD wells. The maps and summaries developed are used in this report to document the operation of the system over the past year and to illustrate the effectiveness of the system. The original data received from SCC has been reproduced and appended to this report for reference.

PART II: DATA COLLECTION

Ground-Water Monitoring

12. In early January 1984, a project coordination meeting was held at RMA during which personnel from RMA, SCC, and WES defined the responsibilities for the FY84 program. It was decided that quarterly monitoring and sampling of the monitoring wells would be conducted in January, April and July. WES with support from RMA would be responsible for conducting water level measurements while SCC with support from their onsite contractor would be responsible for collecting ground-water samples and performing DBCP analyses. Water level measurements were to be conducted prior to ground-water sampling. On completion of the analyses, SCC was to furnish the results to RMA and WES.

Water level measurements

13. A number of water level measurements were taken over the period of the investigation as indicated in Table 1. The 16-25 January 1984 water levels were taken immediately prior to the scheduled January ground-water sample collection. Additional wells were added to the monitoring list and all the wells were remeasured during 6-7 February. Water level measurements were taken on these same monitoring wells during 3-4 April as part of the scheduled April sampling. During 11-12 May and on 4 June, water level measurements were taken on a selected group of monitoring wells which are located on the Arsenal in the vicinity of the SACWSD wells. These measurements were taken to determine the impact of increased production by the SACWSD wells on the ground-water flow in the area of the control system. Water level measurements were taken on all of the monitoring wells during 26-28 June as part of the scheduled July sampling. On 2 August, water level measurements were taken on the new "RSD" monitoring wells constructed along 7th Avenue. On 8 August, water level measurements were again taken from selected wells in the vicinity of the SACWSD wells.

14. All water level measurements were taken using a battery-powered electrical probe which uses the slight electrical conductivity of water to sense the water surface. Water levels were converted to elevations using existing topographic surveys. The vertical control data for the monitoring

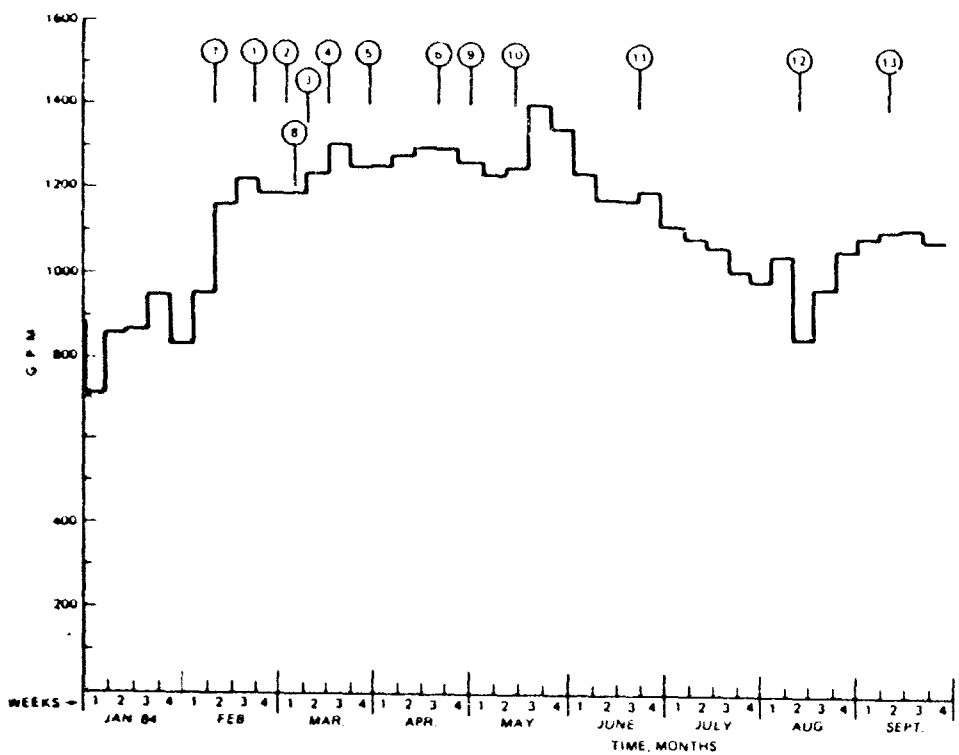
wells were taken from several sets of survey data that were performed by different surveyors and these sets of survey data have resulted in variations in absolute ground-water elevations in some areas.

Ground-water sampling

15. Ground-water samples were collected during 16-27 January, 9-25 April, and 3-25 July as part of the three scheduled quarterly samplings (see Table 2 and Appendix). These samples were collected by SCC's onsite contractor and the analyses were performed by another SCC contractor. On 2 August, ground-water samples were collected from the new "RSD" monitoring wells by WES personnel. The samples were analyzed for DBCP by the RMA analytical laboratory. All samples were collected using a bailing technique. Standing water in each well casing was evacuated and the well allowed to recover prior to sample collection. Sampling equipment was carefully cleaned prior to sampling of each well to prevent cross-contamination.

Plant Operation, Well Production, and Flow Rates

16. SCC provided monthly summaries of total flow through the treatment plant. A summary of this data over the FY84 study period is presented in Figure 6. SCC's contractor periodically collected samples of influent and effluent to and from the treatment plant. These samples were analyzed for DBCP by another SCC contractor and the results supplied to RMA and WES by SCC. These results are summarized in Table 3. Monthly production rates for the SACWSD wells were obtained from the SACWSD and are summarized in Figure 7. Data from 1982 and 1983 are included for reference.



NOTES

(1) V-101 AND V-102 ADSORBERS DOWN PERIODICALLY 2/23-24 TO CHECK CARBON LEVELS AND ADD CARBON

(2) V-101 AND V-102 ADSORBERS DOWN PERIODICALLY 3/1-2 TO CHECK CARBON LEVELS AND ADD CARBON

(3) V-101 AND V-102 ADSORBERS DOWN PERIODICALLY 3/8-9 TO CHECK CARBON LEVELS AND ADD CARBON

(4) V-101 AND V-102 ADSORBERS DOWN PERIODICALLY 3/15-16 TO CHECK CARBON LEVELS AND ADD CARBON

(5) V-101 AND V-102 ADSORBERS DOWN PERIODICALLY 3/29-30 TO CHECK CARBON LEVELS AND ADD CARBON

(6) V-101 AND V-102 ADSORBERS DOWN PERIODICALLY 4/26-27 TO CHECK CARBON LEVELS AND ADD CARBON

(7) PUT SIX NEW RECHARGE WELLS (I-15 THRU I-20) IN SERVICE ON 2/10

(8) ESTIMATED FLOW. V-102 TOTALIZER FAILED DURING WEEK OF 3/5

(9) ESTIMATED FLOW. V-101 TOTALIZER FAILED 4/27. BOTH TOTALIZERS BACK IN SERVICE ON 5/4. V-101 AND V-102 ADSORBERS DOWN PERIODICALLY ON 5/2 AND 5/8 TO CHECK CARBON LEVELS AND ADD CARBON. UNIT DOWN 0800-1630 ON 5/4 TO INSTALL NEW UNIT GUARD FILTERS. PUT NEW RECHARGE WELLS I-21 AND I-22 IN SERVICE ON 5/4 AND 5/8, RESPECTIVELY.

(10) UNIT DOWN 0800-1230 ON 5/14 TO REPAIR BROKEN DISCHARGE LINE FROM ADSORBERS. PUT NEW EXTRACTION WELLS W-34, W-35, AND W-36 IN SERVICE ON 5/15, AND W-38 AND W-37 IN SERVICE ON 5/17 AND 5/21, RESPECTIVELY.

(11) UNIT DOWN APPROXIMATELY 80 MINUTES ON 6/22 DUE TO LIGHTENING STRIKE AND RESULTING POWER FAILURE

(12) UNIT DOWN 2000 ON 8/12 TO 0730 ON 8/13 DUE TO POWER FAILURE. P-102 DOWN ON 8/12. P-102 REPLACED ON 8/16, BUT BROKEN PIPE KEPT UNIT ON ONE SUMP PUMP UNTIL 8/20. BOTH PUMPS ON SEPARATELY TO ADSORBERS ON 8/2

(13) SUMP LEVEL CONTROLLER PUT IN SERVICE DURING 9/4 THRU 9/7.

Figure 6. Total flow through the Irondale Treatment System

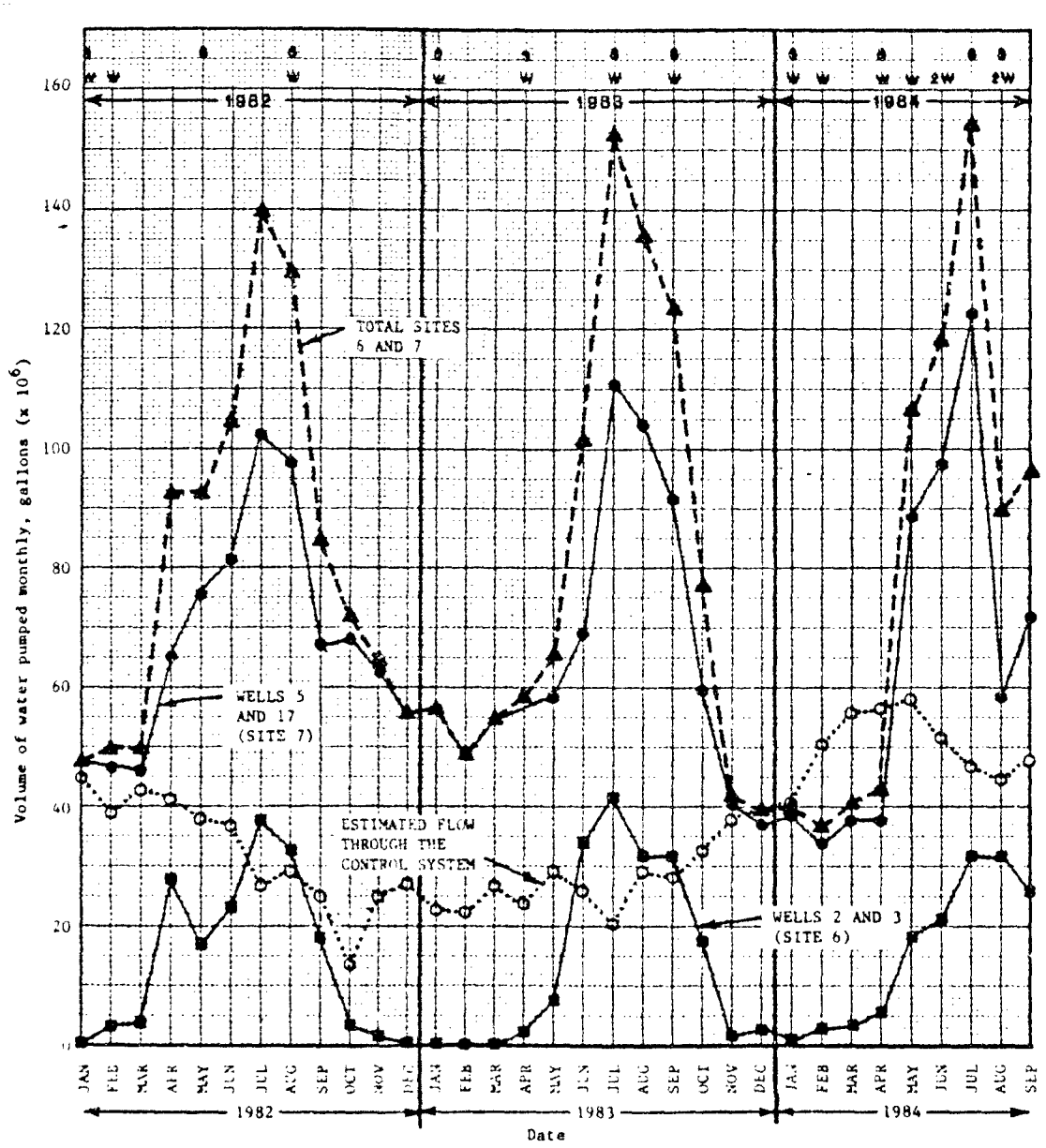


Figure 7. Volume of water pumped by the SACWSD wells at sites 6 and 7 and the estimated flow through the Irondale DBCP Control System. The "S" and "W" indicate when water samples and water level readings, respectively, were taken on RMA.

PART III: DATA ANALYSIS

Control System Operation

Flow through the treatment plant

17. Weekly water flow rates through the Irondale DBCP Control System treatment plant during the period January 1984 thru September 1984 are presented in Figure 6. Operational factors and incidents which effected the quantity of flow through the plant are noted on the figure along with the date of occurrence. Problems with the recharge wells restricted flow through the plant to 700 to 900 gpm during January and the first part of February. During the middle of February, after six new recharge wells were placed in operation, the flow increased to approximately 1200 gpm. The flow through the plant continued at a rate of 1200 to 1300 gpm until the middle of May. After two additional recharge wells and five new extraction wells were placed in operation in early May, the flow rate increased to a maximum for study period of 1400 gpm. The flow rate decreased to 1000 to 1100 gpm in June and July. The flow decreased to less than 900 gpm during the middle of August due to a power failure, downtime for installation of new equipment, and equipment problems. By the end of September, the flow had increased to approximately 1100 gpm.

18. Factors associated with control system operation which appear to have significantly effected the flow through the plant during the study period are the construction and operation of the new extraction and recharge wells and certain equipment failures. The new extraction wells increased the area of ground- water flow intercepted by the system and together with the new recharge wells probably resulted in a higher recycle rate at least until some equilibrium was reached.

DBCP removal

19. Influent and effluent DBCP concentrations for the treatment plant over the period February 1984 thru July 1984 are presented in Table 3. The maximum DBCP concentration found in the influent was 0.28 ppb. DBCP concentrations in all of the effluent samples were below the detection level except for a sample collected on 11 June from adsorber V-102 in which DBCP was reported

as being "present." The effluent from adsorber V-102 was resampled on 18 June and the DBCP concentration was found to be below the detection level.

Analysis of Ground-Water Elevations

20. The ground-water elevations obtained during the three scheduled quarterly samplings (see Table 1) were used to prepare water level elevation maps which are presented as Plates W-1 thru W-3. Together, these maps reflect the changes which occurred during FY84 in the ground-water elevations and flow patterns caused by seasonal changes and operation of the control system and SACWSD wells. Each map is discussed in detail below. The additional ground-water elevation data obtained from selected wells in the vicinity of the SACWSD wells is discussed later.

January 1984 sampling period

21. Water level elevations measured during 16-25 January did not provide sufficient data to construct a water level elevation map. Additional wells were added to the monitoring list and all the wells were measured during 6-7 February. Water level elevations observed during 6-7 February (Plate W-1) indicate a depression or trough formed along the line of extraction wells in row 2 and a ground-water mound along the line of recharge wells which is skewed toward the southwest end of the line. The water level along row 2 is approximately 2 feet higher than it was during the last quarterly sampling in September 1983 (3). The closely spaced contour lines on the southwest end of the row 2 represent a steep gradient and indicate a significant drawdown by the extraction wells in this area. However, it should be noted that the saturated thickness of the alluvial aquifer prior to operation of the control system was 3 to 4 times greater on the southwest end of row 2 than on the northeast end. The water level gradient between the two rows of extraction wells is fairly flat. The bulge in the 5104 ft isopleth northeast of the control system is probably the result of surface discharge of treated water from the treatment plant which occurred during the previous three months.

22. The maximum water level observed in the mound, 5111.3 ft at well S-1 (see Table 1) is nearly identical to the maximum observed during the last quarterly sampling. However, the data indicate that the mound has expanded

slightly in areal extent since that time. Ground-water withdrawal from the SACWSD wells at site 7 has resulted in the formation of a cone of depression (SACCD) that extends to well 33-12. However, this depression does not appear to be significantly effecting the ground-water flow along the southwest end of the control system during this period.

April 1984 sampling period

23. Water level elevations observed during 3-4 April (Plate W-2) indicate a general increase in ground-water levels, some changes in the depression between the two rows of extraction wells and a significant increase in water levels in the mound along the row of recharge wells since the last sampling period. A shallow trough with an elevation of about 5103 ft has formed near wells 8, 1, 2, 3, and 4 in row 1, while the water levels along the southwest end of row 1 have increased. The higher water levels are due to the increased height of the mound on the southwest end of the row of recharge wells and a generally higher ground-water level. The gradients indicate that some water from the recharge wells was being recycled by the row 1 extraction wells and possibly by the extraction wells on the southwest end of row 2. The spacing between the contour lines at the southwest end of row 2, near well 33-582, is similar to the last sampling period and indicates continued significant drawdown in this area. The bulge in the 5104 ft isopleth northeast of the control system is no longer evident indicating that the slight mounding observed during the previous sampling period has dissipated.

24. The maximum water level observed in the ground-water mound, 5120.5 ft at well S-1 (see Table 1), is approximately 9 ft higher than the maximum observed during the last quarterly sampling. This variation is due to the increase in flow through the control system, approximately 1300 gpm, during this period as opposed to 900 gpm during the last sampling period (see Figure 6). The SACCD shows little change with respect to the last quarterly sampling. It does not appear that the ground-water withdrawal by the site 7 SACWSD wells occurring during this period has much of an impact on ground-water flow patterns in the area of the control system.

July 1984 sampling period

25. Water level elevations observed during 26-28 June (Plate W-3) indicate an increase in the depth and areal extent of the depression around the two rows of extraction wells and a change in the ground-water mound along the row of recharge wells since the last sampling period. The mound has developed a "two-humped" appearance with maximum water level elevations of 5115.5 ft and 5115.3 ft (see Table 1) at wells 33-576 and S-1, respectively. These elevations are approximately 5 feet less than the maximum observed during the last sampling period. These lower elevations are probably due to the wider distribution of the recharged flow through use of the new recharge wells on the southwest end of the line and to a small decrease in total water flow through the system (see Figure 6).

26. A pronounced trough with a low of about 5100 ft developed along the row 2 extraction wells. Based on the elevation of the top of the Denver formation (see Plate 2), the alluvial aquifer in the area of extraction wells 25 and 15 thru 20 was essentially dewatered. The addition of 5 extraction wells on the southwest end of the system, 3 on row 2 and 2 on row 1, increased the effectiveness of the system. The water levels for this sample period appear to show the system has formed a very effective hydrologic barrier. The steep gradient in the ground water between wells 33-9 and 33-10 appears to be caused totally by the control system extraction wells. However the water levels for this particular time period do not clearly show the effects of the SACWSD wells at Site 7. No cone of depression associated with the Site 7 wells is evident at well 33-12, however Figure 7 shows the Site 7 wells pumped the greatest monthly volumes of water in June and July. The effects of the SACWSD wells on the control system are discussed in the next section.

Influence of the SACWSD Wells on Ground-Water Flow in the Vicinity of the Control System

27. The withdrawal of ground water by the SACWSD wells has been observed to periodically effect the ground-water flow patterns in the area immediately south of the control system. This effect has been evidenced by the SACCD that

extends onto the Arsenal in the vicinity of well 33-12. Ground-water data collected over the last three years to monitor the effectiveness of the control system show the SACCD varies during each year. Data showing the volume of water pumped by the SACWSD wells and the control system extraction wells and related changes in the ground-water levels indicate the SACCD could be influencing ground-water flow patterns along the southwest end of the control system. The volume of water pumped by the Site 7 wells during the summer months has increased each year since 1982.

28. Figure 7 shows the variations in the pumping rates of the SACWSD and control system wells. The production data for the Site 6 wells are shown on Figure 7, however these wells don't have a significant impact on the control system and therefore will not be further discussed. The 1984 pumping rates of the Site 7 wells increased from about 37 million gallons a month from January thru April to a high of about 123 million gallons in July then declined to about 58 million gallons in August. The estimated flow through the control system was calculated from the pumping rates shown in Figure 6. The flow through the control system in 1984 increased from about 41 million gallons in January to a high of about 58 million gallons in May, then declined to about 45 million gallons in August. A small percentage of the control system flow was recycled water from the area of the recharge wells. The greatest monthly volume of water pumped by the Site 7 wells occurred in July of each year since 1982, and this volume has steadily increased from about 103 million gallons in 1982, to about 111 million gallons in 1983, to about 123 million gallons in 1984.

29. The combined effects of the control system and SACWSD wells on the ground-water level can be seen in three ground-water profiles the locations of which are presented in Figure 8. The profiles are presented in Figures 9 and 10. Profile 1, which is generally parallel to ground-water flow, starts at well 33-16 and extends northerly through well 33-10 (Figure 8). Profile 2, which is perpendicular to ground-water flow, extends from the northern end of Profile 1 in a northeasterly direction to well 28-18. Profile 2 is about 100 ft northwest of the row 1 extraction wells and 400 ft southeast of the row of recharge wells. Water level measurements for 11-12 May, 4 June and 3 August were from a limited number of wells. As a result, the profile lines for these

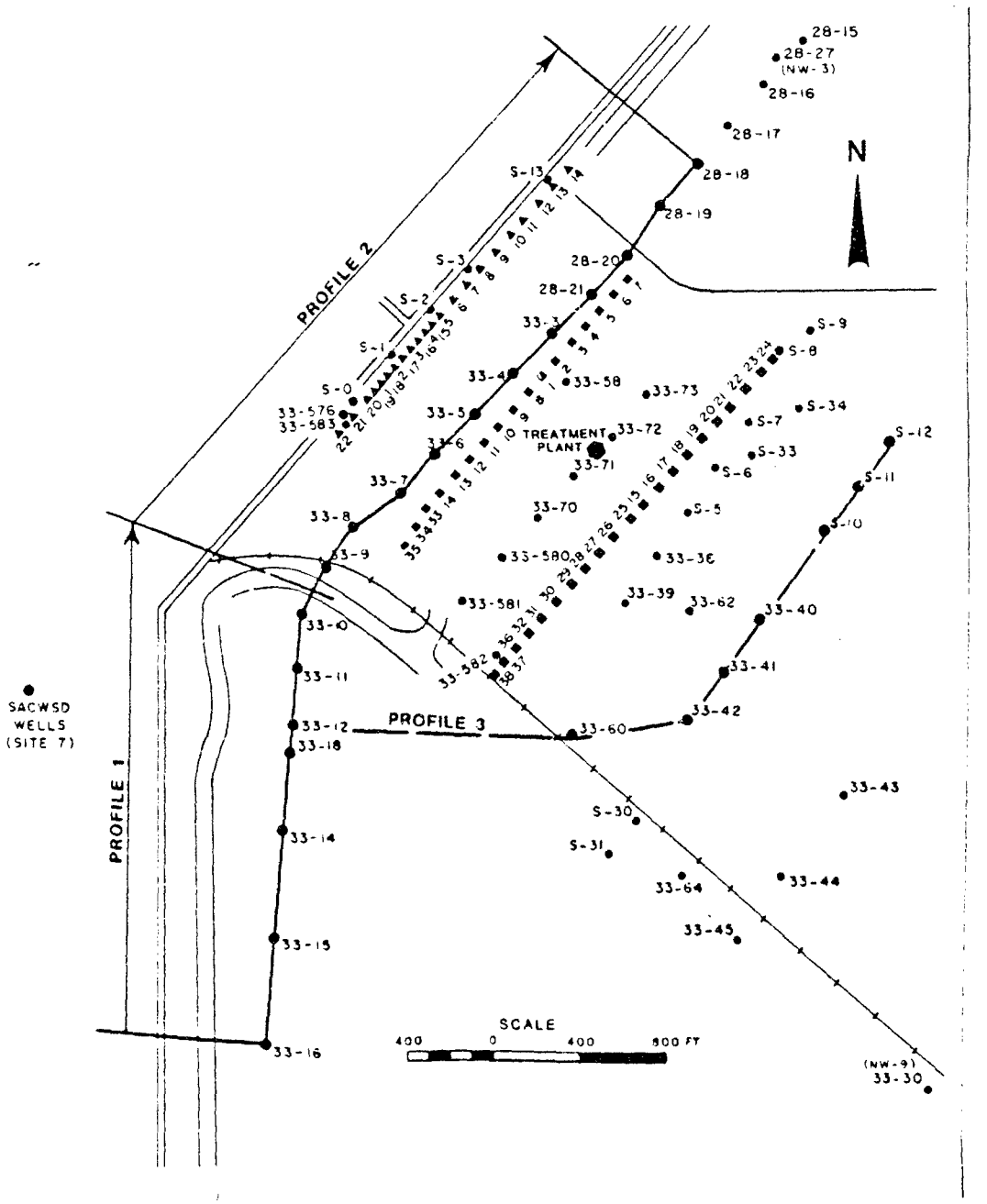


Figure 8. Location of ground-water profiles 1, 2 and 3.

periods of time only extend from well 33-15 to well 33-6 on Profiles 1 and 2 (Figure 9).

30. The SACCD is most evident in RMA well 33-12 where the greatest recorded drawdown occurred on 8 August. Recorded changes in the water level elevations at well 33-12 varied from a high of 5106.09 ft on 26-28 June to a low of 5096.03 ft on 8 August. The changes in water levels on Profile 1 mainly reflect the pumping rate at Site 7. The water levels along Profile 1 were highest in February and April when pumping rates at Site 7 were lowest and gradually decreased from April thru August as the volume of water pumped by the Site 7 wells increased. The 26-28 June water levels are the only exception. The SACWSD wells operate on an intermittent basis which depends on demand. Evidently the Site 7 wells had been shut off or production greatly reduced prior to the 26-28 June water level readings, resulting in a significant reduction in the areal extent of the SACCD. The steep gradient between wells 33-9 and 33-10 on 26-28 June indicate that the new control system extraction wells prevented or slowed down the ground-water recovery rate in this area.

31. Profile 2 shows the combined effects of the recharge wells, the row 1 extraction wells, and the Site 7 wells. The pronounced ground-water mound on the southwest end of the row of recharge wells (see Plates W-1, W-2 and W-3) is evident along the profile line near well 33-7. The water-level profiles show that the effects of the recharge from the ground-water mound were less evident in June and August than from February thru May. The 4 June and 8 August profiles show the ground-water gradient sloping from well 33-7 down toward well 33-12 in the direction of the SACCD. This indicates that the SACCD could have been drawing ground water from the southwest end of the control system. However, the 26-28 June profile shows that the new control system extraction wells maintained the drawdown in the area of wells 33-8 and 33-9, even though the areal extent of the SACCD had been significantly reduced. Thus, it is difficult to quantify the impact of the SACCD on the ground-water flow along the southwestern end of the control system over this study period because of variations in flow through the system resulting in fluctuations in the height and extent of the mound, and due to the construction and operation of the new extraction and recharge wells.

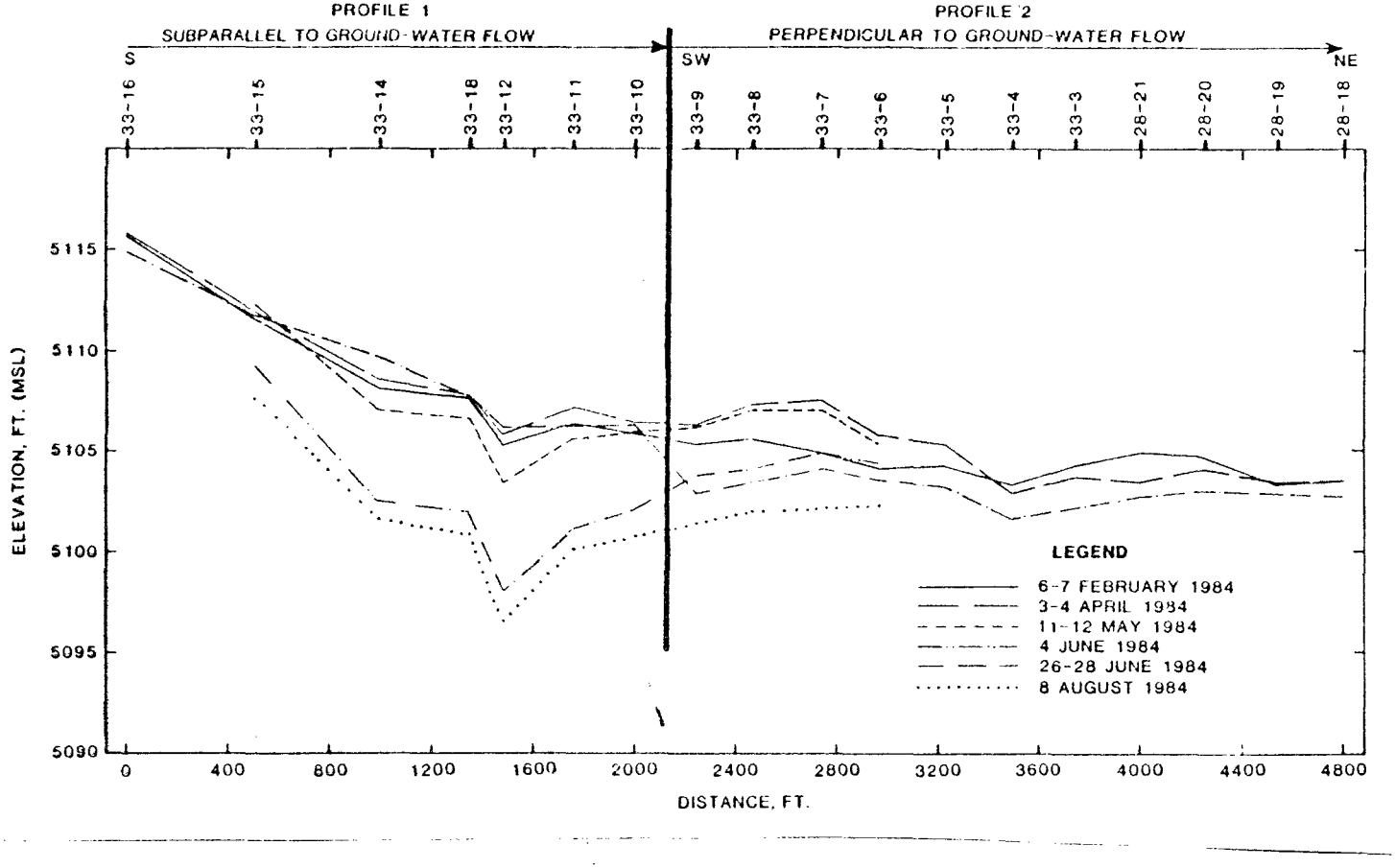


Figure 9. Ground-water profiles 1 and 2.

32. Profile 3 (Figure 10) extends from well 33-12 in an easterly direction to well 33-42 and then northeasterly to well S-12. The section of the profile between wells 33-42 and S-12 is perpendicular to the ground-water flow direction and generally parallel to the row 2 extraction wells. The ground-water surface between wells 33-42 and S-12 slopes down to the northeast because the alluvial aquifer is thinner to the northeast and therefore more effected by the extraction wells. The alluvial aquifer in the area of S-12 was dewatered when the 26-28 June water level readings were taken. The degree of the slope of the ground-water surface decreased as the drawdown by the SACCD increased from February to August. The ground-water gradient from well 33-60 to 33-12 increased from 0.04 ft/mile in April to 0.08 ft/mile in August. The drawdown in the area of well 33-60 during the June and August periods can be attributed to the combined effects of the SACCD and the 3 new row 2 extraction wells.

Analysis of DBCP Concentration in the Ground Water

33. The DBCP concentration data obtained during the three scheduled quarterly sampling periods and the data obtained from the RSD monitoring wells on 2 August (see Table 2) were used to prepare concentration maps which are presented on Plates N-1 thru N-3. Together, these maps reflect the changes which occurred during FY84 in the ground-water DBCP concentrations around the control system. Each map is discussed in detail below.

January 1984 sampling period

34. The DBCP concentration distribution found during 16-27 January (Plate N-1) is similar to the distribution found during the last few sampling periods in FY83 (3). An isolated plume extends from well 33-30 northwesterly into the area of the control system. The highest concentration found was 1.48 ppb in well 33-30. The 0.5 ppb isoconcentration contour extends across the southwest end of the row 2 extraction wells. The 0.2 ppb isoconcentration contour extends across row 2 and up to the southwest end of row 1. Further southeast, along 7th Avenue a DBCP concentration of 0.88 was found in well S-28. None of the other samples collected from monitoring wells around well S-28 were found to contain DBCP in concentrations above the detectable level (0.06 ppb). Another isolated plume is centered around well S-23 in the

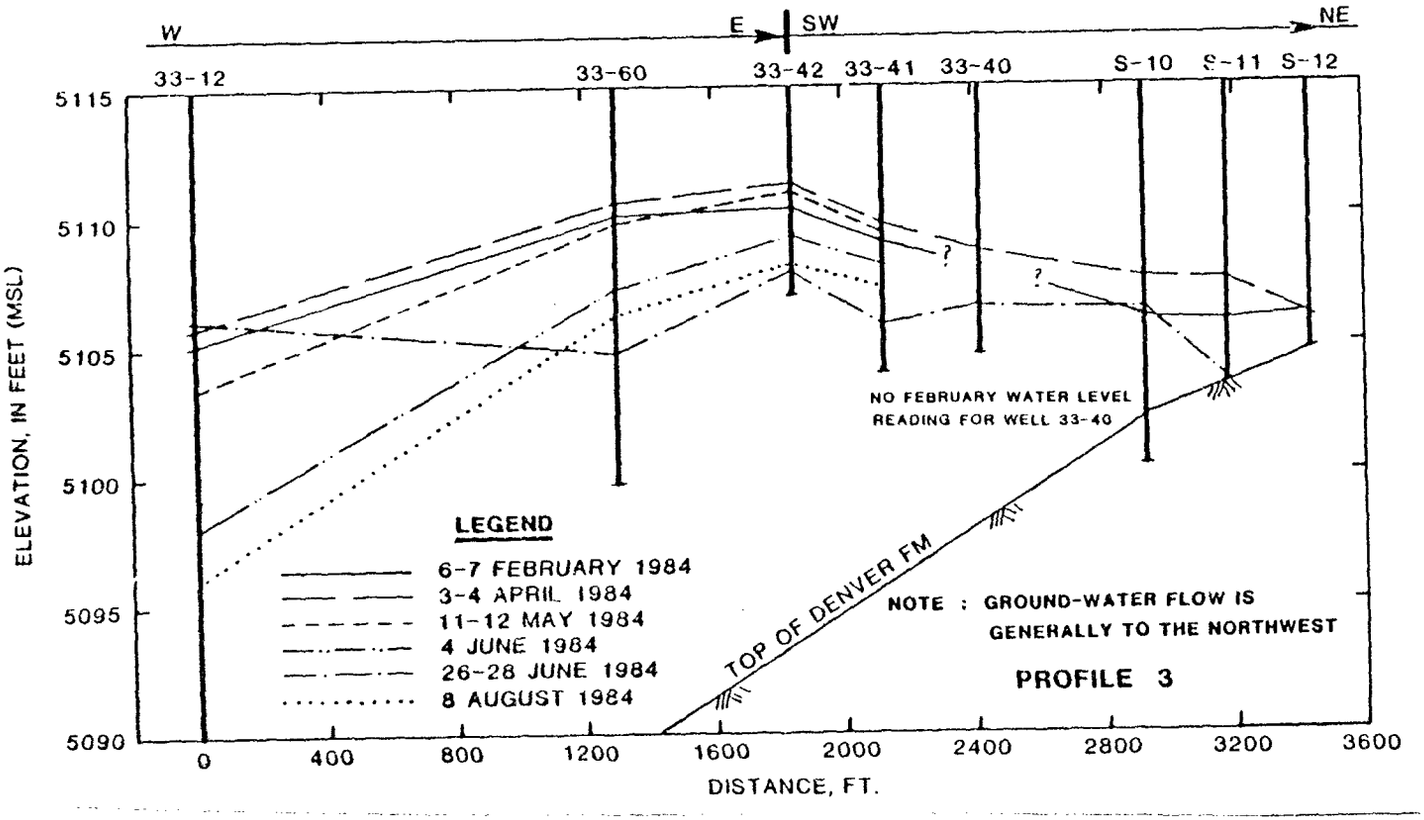


Figure 10. Ground-water profile 3.

railyard area. A DBCP concentration of 104 ppb was found in the sample collected from well S-23. This is the highest concentration found during the January sampling period.

35. No DBCP concentrations above the lowest reportable level (0.20 ppb) were found in any of the monitoring wells immediately northwest of the line of recharge wells. No concentrations above the detectable level were found in any of the wells in the Irondale community.

April 1984 sampling period

36. The DBCP concentration distribution found during 9-25 April (Plate N-2) is similar to the distribution found in the previous sampling period with the exception that no DBCP was found in the area of well S-28. The plume immediately southeast of the control system is slightly narrower than in the previous sampling period. A DBCP concentration of 0.52 ppb was found in the sample collected from well 30-30, lower than during the previous period. Slightly higher concentrations were found in wells 33-42, 33-62, and 33-38 during this period. A concentration of 61.0 ppb was found in the sample collected from well S-23 in the railyard area. This is approximately 43 ppb lower than the last sampling period. No concentrations above the detectable level were found in any of the monitoring wells immediately northwest of the line of recharge wells or in any of the wells in the Irondale community.

July 1984 sampling period

37. The DBCP concentration distribution found during 3-13 July and 2 August (Plate N-3) is significantly different from the distribution previously found. This is due to the availability of additional concentration data from samples collected from the new "RSD" wells on 2 August. Previous to this sampling period, there was insufficient data to determine if and how the two isolated plumes were connected. Based on the data collected from the new wells, it now appears that the plumes are connected and meaningful isoconcentration contours can be drawn. This long, narrow plume extends northwest from well S-23 in the railyard area, across 7th Avenue in the vicinity of cluster well RSD-1, and continues northwesterly to the control system. A DBCP concentration of 58.0 ppb was found in the sample from well S-23, slightly lower than during the last sampling period. Concentrations of 16.8 and

2.65 ppb were found in samples from the new wells 4-26 (top screen of RSD-6) and 4-13 (top screen of RSD-1), respectively.* Concentrations in the plume continue to decrease to the northwest as evidenced by a concentration of 1.48 ppb at well 33-30 and a concentration of 1.31 ppb at well 33-44. The plume ends at the row 2 extraction wells with the exception of a small area on the southwest end which extends across row 2 into the area of well 33-581 where a concentration of 0.51 ppb was found in the respective sample.

38. It is interesting to note that no DBCP was found in samples collected from wells S-28 or S-29, indicating that the plume is less than 400 ft wide in this area. As in the last sampling period, no DBCP concentrations above the detectable level were found in any of the monitoring wells immediately northwest of the line of recharge wells, or in any of the wells in the Irondale community.

Vertical distribution of DBCP

39. Some limited information on the vertical distribution of DBCP was obtained during the July sampling period. Prior to this period, none of the samples collected from any of the cluster wells in the area of the control system were found to contain DBCP. However, samples collected on 2 Aug from two of the new cluster wells, RSD-1 and RSD-6, were found to contain DBCP. Cluster well RSD-1 contains four screens, wells 4-13 thru 4-16, each of which screens a separate 10-ft interval of the alluvial aquifer. Well 4-13 is screened at the top of the aquifer and well 4-16 is screened at the bottom of the aquifer. DBCP concentrations of 2.65, 4.93, 3.42, and 0.73 ppb were found in the samples collected from wells 4-13, 4-14, 4-15, and 4-16, respectively.

40. Cluster well RSD-6 also contains four screens, wells 4-26 thru 4-29. Well 4-26 is screened at the top of the alluvial aquifer and well 4-29 is

*The "RSD" wells are cluster wells which screen the total thickness of the alluvial aquifer in 10 ft intervals. The DBCP concentrations found in the samples collected from the top screened interval of each cluster well were used to map the isoconcentration contours. This was done to provide consistent data since many of the older monitoring wells in this area are screened only in the top part of the alluvial aquifer. Use of the other concentration data collected for the "RSD" wells would not have changed the shape of the plume since DBCP was found vertical distributed throughout the aquifer in these "RSD" wells where DBCP was found.

screened at the bottom of the aquifer. DBCP concentrations of 16.8, 2.43, 0.87, and 0.70 ppb were found in the samples collected from wells 4-26, 4-27, 4-28, and 4-29, respectively. The data indicate that in this area of the plume northwest of the railcar storage area, DBCP is distributed throughout the vertical extent of the alluvial aquifer. In general, the concentration of DBCP in the ground water tends to decrease with depth.

PART IV: EFFECTIVENESS OF THE CONTROL SYSTEM

41. The Irondale DBCP Control System was constructed for the primary purpose of eliminating the migration of DBCP contaminated groundwater off the Arsenal and into the Irondale community. In order to evaluate the overall effectiveness of the operating system in achieving this purpose, the ability of the system to intercept and control contaminated ground-water flow and remove DBCP from this flow must be assessed. The data collected during the FY84 study period indicates that the control system has been effective in meeting both these requirements. The ground-water elevation maps indicate that the extraction wells have produced a general depression in the ground-water levels around the system. The mound created by the recharge of treated water has produced a ground-water divide resulting in a reversal of the natural ground-water gradient back to the southeast. As a result of both these conditions, ground water in the vicinity of the system tends to flow radially into the area bounded by the two rows of extraction wells thus providing a positive control on ground-water flow.

42. The DBCP concentration maps indicate that the control system is effectively intercepting and removing the flow of DBCP contaminated ground water flowing toward the Arsenal boundary. The data indicate that the installation of additional recharge wells and extraction wells, and the reworking and replacement of some older extraction wells, has improved the effectiveness of the control system. The data obtained from the analysis of influent and effluent samples from the treatment plant indicate that the plant is effectively removing DBCP resulting in the recharge of contaminant-free water. The effectiveness of the control system is further evidenced by the fact that no DBCP concentrations above the detectable level were found in any of the samples collected from wells in the Irondale community. Thus, the data indicate that the Irondale DBCP Control System is effectively eliminating the migration of DBCP contaminated ground water off the Arsenal and into the Irondale community.

43. The significance of the impact of ground-water withdrawal by the SACWSD wells on the control system over the study period is difficult to quantify. The ground-water profiles indicate that the SACCD does periodically

approach the southwestern end of the control system area. During these times, the ground-water gradients slope to the south/southwest indicating a potential for flow away from the control system. The expansion SACCD into these areas occurred from May thru September when the greatest volume of water was being withdrawn by the SACWSD wells. It appears that the SACCD forms and dissipates rather quickly in response to well operation.

44. The 16-27 January and 9-25 April DBCP plume maps (Plates N-1 and N-2, respectively) show the 0.2 ppb isoconcentration line immediately southwest of the southern end of the row 2 extraction wells, and that in general, the DBCP found between the two rows was concentrated at the southwestern end of the system. This skewed distribution may have resulted in part from a periodic flow of ground water to the south. The 3-13 July DBCP plume map (Plate N-3) indicates that the portion of the plume extending across row 2 was reduced in size. This is probably primarily due to the operation of the new extraction wells and as a result this portion of the plume should continue to shrink in size.

45. DBCP was not found in any of the sampled monitoring wells south of the railroad in this area which in general indicates that DBCP is not migrating toward the SACWSD wells even though ground water periodically flows south and southwest away from the control system in response to ground-water withdrawal by the SACWSD wells. It should be noted that the availability of monitoring data in this area is limited since the only monitoring wells southwest of the control system are along the RMA boundary.* Therefore, monitoring in this area and close coordination with the SACWSD should be continued. Any significant increase in ground water withdrawal by the SACWSD wells could increase the areal extent of the SACCD resulting in an increase in the potential for impact on the control system.

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* Some of the monitoring wells along the boundary, for example wells 33-11 and 33-12, were not sampled in this study due to the potential for nonrepresentative results. Wells 33-11 and 33-12 have 4-ft screens (length) located at the base of the alluvial aquifer, which is 34 ft and 59 ft thick, respectively. Thus, these screens intercept only a small portion of the total flow through the aquifer.

PART V: CONCLUSIONS

46. Based on the results of this study, the following conclusions have been drawn:

a. The water table elevation and Nemagon concentration maps indicate that the Irondale DBCP Control System is intercepting and removing the DBCP contaminated ground water in the area where the control system extraction wells control the ground-water flow.

b. The addition of 5 extraction wells and 8 recharge wells and the overhauling and/or replacement of a number of extraction well pumps increased the effectiveness of the control system.

c. Analytical data generated over the study period indicate that the carbon adsorption treatment plant is effectively removing DBCP resulting in the recharge water with no detectable concentration of DBCP.

d. The overall effectiveness of the control system is evidenced by the fact that no DBCP concentrations above the detectable level were found in any of the samples collected from wells in the Irondale community.

e. The analytical data from the new RSD wells along 7th Avenue indicate a continuous plume of DBCP extends from the railyard area in Section 3 northwest to the control system in Section 33.

f. Analytical data indicate that the entire thickness of the alluvial aquifer at well clusters RSD-1 and RSD-6, which is about 35 ft thick, is contaminated with DBCP.

g. Ground-water elevation data collected in June and August indicate that the SACCD may influence ground-water movement along the southwest end of the control system possibly resulting in some flow in the direction of the SACWSD wells at Site 7. However, the data collected during this study indicate that DBCP is not migrating toward the SACWSD wells.

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3. Whitten, C. B. and May, J. H. 1983. "Evaluation of Shell Chemical Company's Ground-Water DBCP Control System, Rocky Mountain Arsenal, Colorado," Final Report Phase II, U. S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

TABLES

Table 1

Ground-Water Elevations in Monitoring Wells Around

The Irondale DBCP Control System

Well No.	Observed Elevation During Each Monitoring Period, ft(msl)							
	16-25 Jan 84	6-7 Feb 84	3-4 Apr 84	11-12 May 84	4 Jun 84	26-28 Jun 84	2 Aug 84	8 Aug 84
S-0	5106.60	5105.81	5112.36	--	--	5108.97	--	--
S-1	5112.78	5111.30	5120.49	--	--	5115.29	--	--
S-2	5111.68	5109.63	5116.85	--	--	5112.41	--	--
S-3	5107.94	5106.72	5109.76	--	--	5108.39	--	--
S-5	--	5104.18	5104.29	--	--	Dry	--	--
S-6	5101.99	5103.15	5103.55	--	--	5099.79	--	--
S-7	5101.32	5103.27	5102.94	--	--	5100.50	--	--
S-8	--	5103.30	5103.42	--	--	5103.28	--	--
S-9	5102.83	5103.46	5104.00	--	--	5102.95	--	--
S-10	5105.70	5106.04	5107.59	--	--	5106.31	--	--
S-11	--	5105.94	5107.54	--	--	5103.61	--	--
S-12	--	5106.23	5106.15	--	--	5101.86	--	--
S-13	5105.62	5105.14	5105.53	--	--	5105.05	--	--
S-14	5119.69	5120.26	5120.63	--	--	5120.45	--	--
S-15	--	5121.28	5121.66	--	--	5121.72	--	--
S-16	--	5125.85	5126.16	--	--	5125.98	--	--
S-17	--	5126.03	5125.84	--	--	5126.08	--	--
S-18	--	5126.36	5126.54	--	--	5126.38	--	--
S-19	--	5126.56	5126.71	--	--	5127.01	--	--
S-22	--	5132.86	5132.97	--	--	5133.21	--	--

(Continued)

Table 1 (Continued)

Well No.	Observed Elevation During Each Monitoring Period, ft(msl)							
	16-25 Jan 84	6-7 Feb 84	3-4 Apr 84	11-12 May 84	4 Jun 84	26-28 Jun 84	2 Aug 84	8 Aug 84
S-23	5141.45	5141.45	5141.53	--	--	5141.82	--	--
S-24	--	5139.23	5139.32	--	--	5139.51	--	--
S-25	--	5139.66	5139.80	--	--	5140.06	--	--
S-26	5125.56	5124.60	5126.63	--	--	5125.55	--	--
S-27	5121.12	5123.99	5124.94	--	--	5125.00	--	--
S-28	5122.91	5122.95	5123.78	--	--	5123.91	--	--
S-29	5122.34	5122.47	5123.28	--	--	5123.14	--	--
S-30	--	Dry	Dry	--	--	Dry	--	--
S-31	--	--	Dry	--	--	5112.49	--	--
S-32	--	5124.23	5124.34	--	--	5124.33	--	--
S-33	5100.31	5103.85	5103.89	--	--	5100.67	--	--
S-34	5102.89	5103.94	5104.24	--	--	5103.38	--	--
3-2	--	5131.26	5131.48	--	--	5131.57	--	--
3-8	--	5158.42	5158.34	--	--	5158.70	--	--
3-9	--	5135.36	5135.51	--	--	5135.78	--	--
3-10	--	5136.18	5138.00	--	--	5136.49	--	--
4-1	--	5125.74	5123.11	--	--	5122.88	--	--
4-2	--	5123.28	--	--	--	--	--	--
4-3	--	5122.64	5121.01	--	--	5120.43	--	--
4-4	--	5122.44	5119.28	--	--	5119.16	--	--
4-7	--	5124.12	5108.47*	--	--	5122.24	--	--

(Continued)

Table 1 (Continued)

Well No.	Observed Elevation During Each Monitoring Period, ft(msl)							
	16-25 Jan 84	6-7 Feb 84	3-4 Apr 84	11-12 May 84	4 Jun 84	26-28 Jun 84	2 Aug 84	8 Aug 84
4-10	--	5129.20	5127.59	--	--	5127.39	--	--
4-15	--	--	--	--	--	--	5123.25	--
4-17	--	--	--	--	--	--	5124.40	--
4-20	--	--	--	--	--	--	5125.05	--
4-22	--	--	--	--	--	--	5122.48	--
4-24	--	--	--	--	--	--	5121.73	--
4-27	--	--	--	--	--	--	5126.97	--
27-42	--	5107.35	5106.91	--	--	5107.29	--	--
27-53	--	5105.59	5105.29	--	--	5105.39	--	--
28-9	--	5100.91	5100.44	--	--	5100.65	--	--
28-12	--	5101.88	5100.99	--	--	5101.49	--	--
28-15	--	5102.79	5101.84	--	--	5102.17	--	--
28-16	--	5104.74	5102.50	--	--	5102.50	--	--
28-17	--	5103.28	5101.94	--	--	5102.46	--	--
28-28	5103.85	5103.51	5103.43	--	--	5102.74	--	--
28-19	5103.44	5103.34	5103.53	--	--	5102.82	--	--
28-20	5104.95	5104.75	5104.11	--	--	5103.00	--	--
28-21	5105.24	5104.95	5103.52	--	--	5102.74	--	--
28-22	--	5105.00	5104.30	--	--	5104.75	--	--
28-23	--	5101.00	5100.51	--	--	5100.58	--	--
28-27	--	5104.29	5102.27	--	--	5103.63	--	--

(Continued)

Table 1 (Continued)

Well No.	Observed Elevation During Each Monitoring Period, ft(msl)							
	16-25 Jan 84	6-7 Feb 84	3-4 Apr 84	11-12 May 84	4 Jun 84	26-28 Jun 84	2 Aug 84	8 Aug 84
33-1	--	5116.08	5115.83	--	--	5115.38	--	--
33-2	--	5119.84	5119.79	--	--	5118.97	--	--
33-3	5104.74	5104.22	5103.71	--	--	5102.21	--	--
33-4	5103.88	5103.18	5102.87	--	--	5101.62	--	--
33-5	5104.93	5104.27	5105.41	--	--	5103.23	--	--
33-6	5104.80	5104.08	5105.75	5105.30	5104.30	5103.50	--	5102.20
33-7	5105.34	5104.88	5107.54	5107.02	5104.92	5104.09	--	5102.13
33-8	5105.30	5105.61	5107.27	5107.03	5104.23	5103.47	--	5102.03
33-9	--	5105.25	5106.39	5106.31	5103.81	5102.91	--	5101.45
33-10	--	5105.82	5106.38	5105.98	5102.18	5106.32	--	5100.83
33-11	--	5106.45	5107.22	5105.55	5101.05	5106.22	--	5100.11
33-12	--	5105.18	5105.81	5103.43	5098.03	5106.09	--	5096.03
33-14	--	5108.10	5108.57	5107.03	5102.53	5109.70	--	5101.60
33-15	--	5111.55	5111.98	5112.26	5109.16	5111.75	--	5107.56
33-16	--	5115.66	5115.85	--	--	5114.98	--	--
33-17	--	5120.25	5120.58	--	--	5120.30	--	--
33-18	5112.40	5107.56	5107.74	--	--	5107.69	--	--
33-19	--	--	--	5106.55	5102.05	5100.65	--	5100.90
33-25	--	5106.52	5105.11	--	--	5103.58	--	--
33-30	5117.02	5117.04	5148.77*	--	--	5132.95*	5115.35	--

(Continued)

Table 1 (Continued)

Well No.	Observed Elevation During Each Monitoring Period, ft(msl)							
	16-25 Jan 84	6-7 Feb 84	3-4 Apr 84	11-12 May 84	4 Jun 84	26-28 Jun 84	2 Aug 84	8 Aug 84
33-33	5110.09	5110.16	5111.45	--	--	5110.92	--	--
33-38	--	5104.95	5105.37	--	--	5109.64*	--	--
33-39	5108.44	5107.64	5107.48	--	--	5104.12	--	--
33-40	5108.44	--	5108.59	--	--	5106.47	--	--
33-41	5108.77	5108.93	5109.74	5109.29	5108.09	5105.67	--	5107.23
33-42	5110.16	5110.31	5111.33	5110.86	5109.16	5107.80	--	5108.08
33-43	5112.32	5112.44	5113.41	--	--	5106.79*	--	--
33-44	--	5113.51	5111.60	--	--	5111.18	--	--
33-45	--	5113.96	5114.83	--	--	5114.79	--	--
33-46	5117.38	5117.54	5118.16	--	--	5115.86	--	--
33-47	5120.64	5120.79	5121.53	--	--	5123.75*	--	--
33-51	5104.42	--	5103.93	--	--	5102.74	--	--
33-57	5104.90	5105.03	5105.36	--	--	5099.60	--	--
33-58	5104.66	5104.70	5102.80	--	--	5106.09	--	--
33-59	5111.72	5111.76	--	--	--	--	--	--
33-60	5110.05	5110.07	5110.56	5109.75	5107.15	5104.83	--	5106.25
33-62	5107.78	5108.03	5108.23	5107.81	5107.11	5104.11	--	5104.26
33-64	5113.47	5114.47	5113.89	--	--	5113.68	--	--
33-70	5104.40	5104.46	5104.38	--	--	5103.19	--	--
33-71	5103.82	5104.08	5104.04	--	--	5102.57	--	--

(Continued)

Table 1 (Concluded)

Well No.	Observed Elevation During Each Monitoring Period, ft(msl)							
	16-25 Jan 84	6-7 Feb 84	3-4 Apr 84	11-12 May 84	4 Jun 84	26-28 Jun 84	2 Aug 84	8 Aug 84
33-72	5103.54	5104.14	5103.17	--	--	5101.75	--	--
33-73	5103.41	5104.43	5103.10	--	--	5101.71	--	--
33-576	5106.42	5105.78	5114.03	--	--	5115.53	--	--
33-577	5105.91	5105.37	5109.02	--	--	5105.52	--	--
33-578	5105.59	5105.14	5107.85	--	--	5103.50	--	--
33-579	5105.46	5105.11	5106.65	5106.34	5103.04	5102.24	--	5100.85
33-580	5104.83	5104.53	5104.62	5106.34	5103.04	5102.57	--	--
33-581	5103.23	5105.84	5106.52	5106.95	5103.35	5102.55	--	5101.86
33-582	5108.13	5108.27	5108.54	5107.82	5104.12	5103.42	--	5103.03
34-2	--	5123.35	5123.74	--	--	5123.24	--	--
34-5	--	5113.60	5113.46	--	--	5111.76	--	--
34-8	--	5112.03	5111.90	--	--	5112.31	--	--

* Probable error in measurement.

Table 2

DBCP Concentrations in Monitoring Wells Around the Irondale DBCP Control System

Well No.	Concentration During Each Sampling Period, ppb			
	16-27 Jan 84	9-25 Apr 84	3-13 Jul 84	2 Aug 84
S-0	P*	BDL**	BDL	--
S-1	P	BDL	BDL	--
S-2	P	BDL	BDL	--
S-3	BDL	BDL	BDL	--
S-6	P	P	BDL	--
S-7	BDL	BDL	BDL	--
S-9	BDL	BDL	BDL	--
S-1	BDL	BDL	BDL	--
S-12	--	BDL	BDL	--
S-13	BDL	BDL	BDL	--
S-14	BDL	BDL	BDL	--
S-23	104.[a]; 70.6[b]	61.0	58.0	--
S-26	BDL	P	BDL	--
S-27	BDL	BDL	BDL	--
S-28	0.88	BDL	BDL	--
S-29	BDL	BDL	BDL	--
S-33	P	P	BDL	--
S-34	BDL	BDL	BDL	--
3-2	BDL	BDL	BDL	--
3-9	1.10	0.82	0.72	--
3-10	BDL	BDL	BDL	--
4-13	--	--	--	2.65
4-14	--	--	--	4.93

(Continued)

[a] Sampled 1/25/84

[b] Sampled 2/17/84

Table 2 (Continued)

Well No.	Concentration During Each Sampling Period, ppb			
	16-27 Jan 84	9-25 Apr 84	3-13 Jul 84	2 Aug 84
4-15	--	--	--	3.46
4-16	--	--	--	0.73
4-17	--	--	--	BDL
4-19	--	--	--	BDL
4-20	--	--	--	BDL
4-21	--	--	--	BDL
4-22	--	--	--	BDL
4-23	--	--	--	BDL
4-24	--	--	--	BDL
4-25	--	--	--	BDL
4-26	--	--	--	16.8
4-27	--	--	--	2.43
4-28	--	--	--	0.87
4-29	--	--	--	0.70
28-19	BDL	--	--	--
28-20	BDL	--	--	--
28-21	BDL	BDL	BDL	--
33-3	BDL	--	--	--
33-4	BDL	BDL	BDL	--
33-5	BDL	--	--	--
33-6	BDL	--	--	--
33-7	BDL	--	--	--
33-8	BDL	BDL	BDL	--
33-10	BDL	BDL	BDL	--
33-18	BDL	--	--	--
33-19	--	BDL	BDL	--
33-20	--	BDL	BDL	--

(Continued)

Table 2 (Continued)

Well No.	Concentration During Each Sampling Period, ppb			
	16-27 Jan 84	9-25 Apr 84	3-13 Jul 84	2 Aug 84
33-30	1.48	0.52	1.48	--
33-33	BDL	BDL	BDL	--
33-39	0.63	0.65	--	--
33-40	0.22	0.17	--	--
33-41	0.36	0.49	0.38	--
33-42	0.89	1.31	--	--
33-43	0.36	P	0.23	--
33-44	0.72	0.30	1.31	--
33-45	BDL	BDL	BDL	--
33-46	--	BDL	BDL	--
33-51	BDL	--	--	--
33-59	BDL	BDL	BDL	--
33-60	0.24	BDL	BDL	--
33-62	0.94	1.57	--	--
33-63	BDL	--	--	--
33-64	BDL	BDL	BDL	--
33-70	0.58	P	BDL	--
33-71	0.44	P	BDL	--
33-72	BDL	BDL	BDL	--
33-73	BDL	BDL	BDL	--
33-576	P	BDL	BDL	--
33-577	P	BDL	BDL	--
33-578	P	BDL	BDL	--
33-579	0.36	P	BDL	--
33-580	0.37	0.25	P	--

(Continued)

Table 2 (Continued)

Well No.	Concentration During Each Sampling Period, ppb			
	16-27 Jan 84	9-25 Apr 84	3-13 Jul 84	2 Aug 84
33-581	0.42	0.27	0.51	--
33-582	0.40	P	P	--
33-583	--	--	BDL	--
M-1	BDL	BDL	BDL	--
M-2	BDL	BDL	BDL	--
M-3	BDL	BDL	BDL	--
M-4	BDL	BDL	BDL	--
M-5	BDL	BDL	BDL	--
M-6	BDL	BDL	BDL	--
C	BDL	BDL	BDL	--
C-III	BDL	BDL	BDL	--
W-2	BDL	BDL	BDL	--
W-4	BDL	BDL	BDL	--
W-6	BDL	BDL	BDL	--
W-8	BDL	BDL	BDL	--
W-10	BDL	BDL	BDL	--
W-12	BDL	BDL	BDL	--
W-14	P	BDL	BDL	--
W-16	0.36	0.89	0.61	--
W-18	0.21	0.28	BDL	--
W-22	BDL	BDL	BDL	--
W-24	BDL	BDL	BDL	--
W-25	BDL	0.45	1.60	--
W-27	0.50	0.50	0.55	--
W-29	0.56	0.33	1.08	--
W-31	P	BDL	0.55	--

(Continued)

Table 2 (Concluded)

Well No.	Concentration During Each Sampling Period, ppb			
	16-27 Jan 84	9-25 Apr 84	3-13 Jul 84	2 Aug 84
W-32	P	BDL	0.77	--
W-33	0.25	BDL	BDL	--
W-34	--	--	BDL	--
W-35	--	--	BDL	--
W-36	--	--	0.21	--
W-37	--	--	P	--
W-38	--	--	P	--

* Present between 0.06 and 0.20 ppb which is the lowest reportable level.

** Below detection level of 0.06 ppb.

Table 3

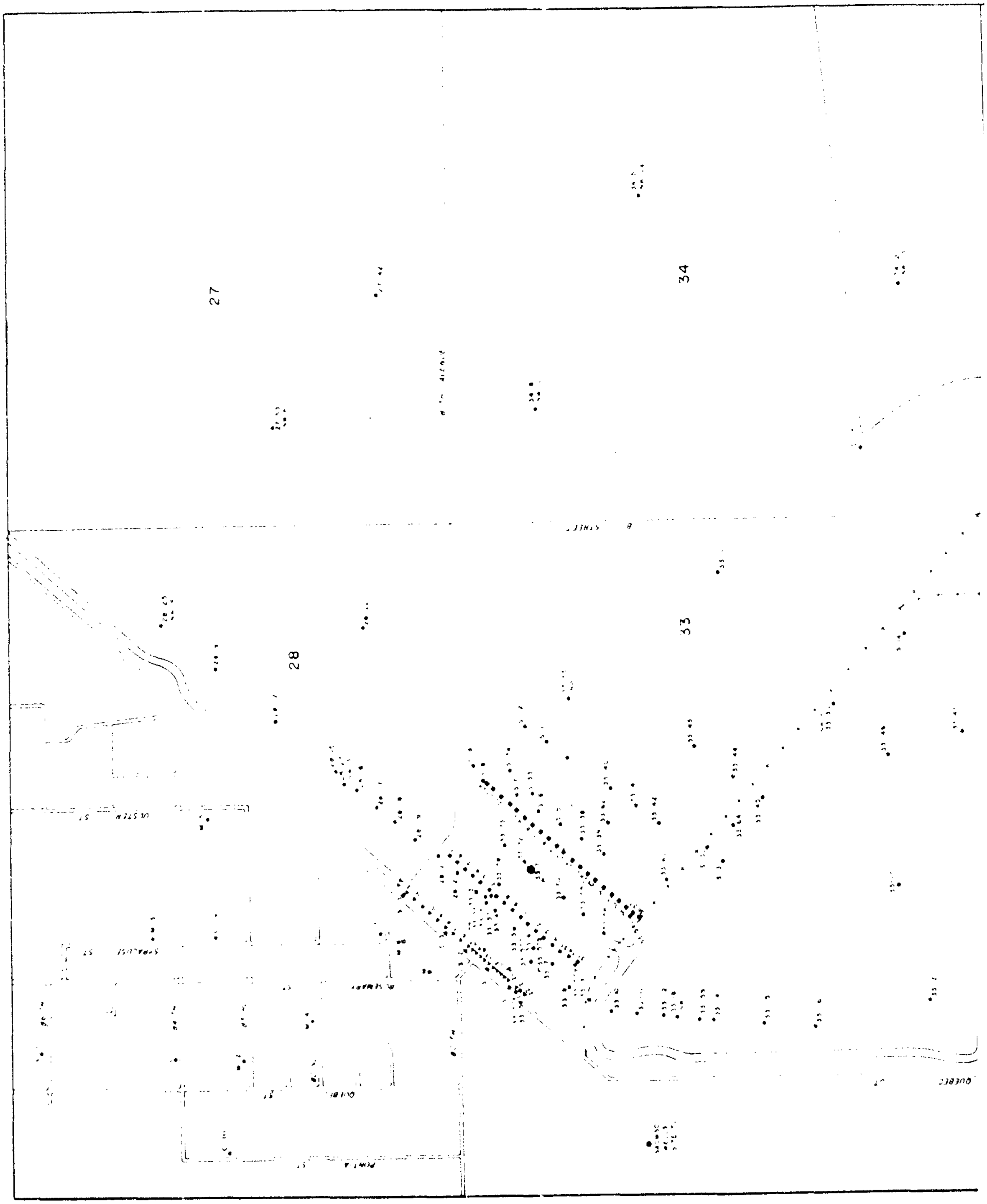
Influent and Effluent Concentrations for the Irondale DBCP Control System Treatment Plant

Sample Date	DBCP Concentration, ppb			
	Adsorber V-101		Adsorber V-102	
	Influent	Effluent	Influent	Effluent
14 Feb 84	--	BDL*	--	BDL
27 Feb 84	0.25	BDL	0.25	BDL
12 Mar 84	--	BDL	--	BDL
26 Mar 84	P**	BDL	P	BDL
9 Apr 84	0.28	BDL	0.28	BDL
23 Apr 84	P	BDL	P	BDL
18 May 84	P	BDL	P	BDL
29 May 84	P	BDL	0.26	BDL
11 Jun 84	0.25	BDL	P	P
18 Jun 84	--	--	--	BDL
25 Jun 84	P	BDL	P	BDL
9 Jul 84	0.23	BDL	P	BDL
23 Jul 84	0.23	BDL	P	BDL
30 Jul 84	--	--	--	BDL

* Below detection level of 0.06 ppb.

** Present between 0.06 and 0.20 ppb which is the lowest reportable level.

PLATES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34
28
33

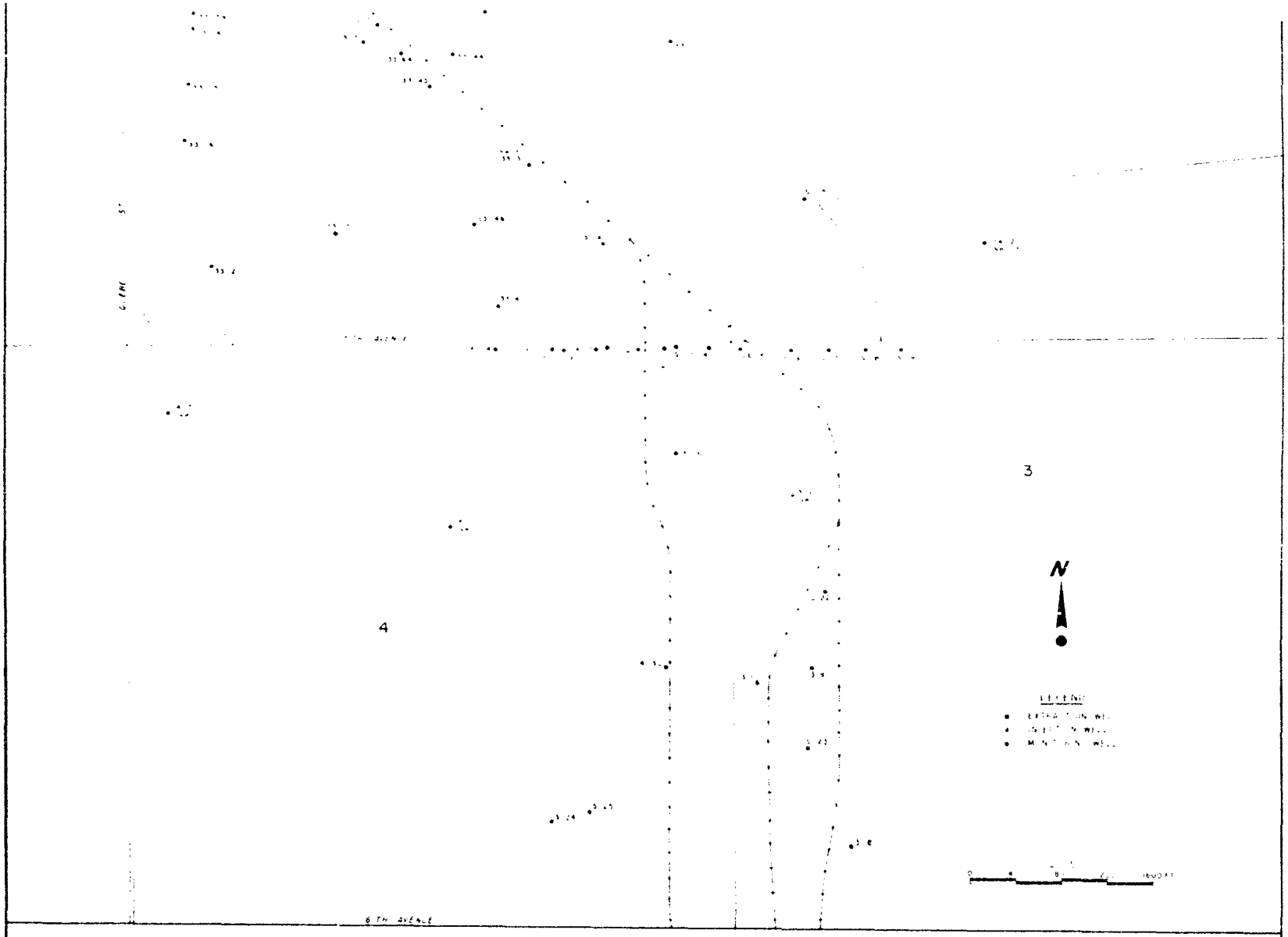
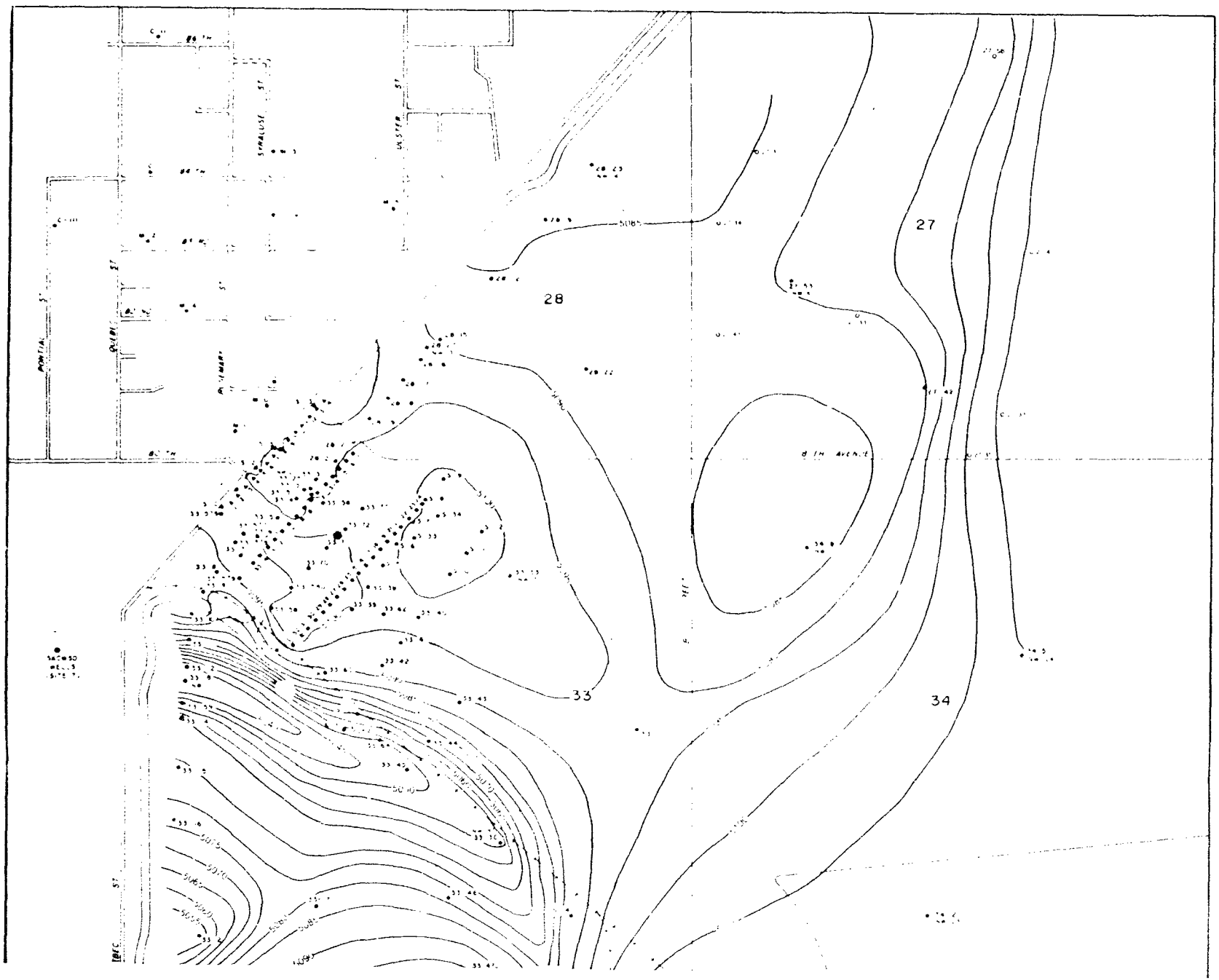


PLATE 1

PREPARED FOR
DEPARTMENT OF THE ARMY
ROCKY MOUNTAIN ARSENAL
COMMERCE CITY, COLORADO
BY
WATERWAYS EXPERIMENT STATION

IRONDALE DBCP CONTROL SYSTEM


28
27
33
34
8TH AVENUE

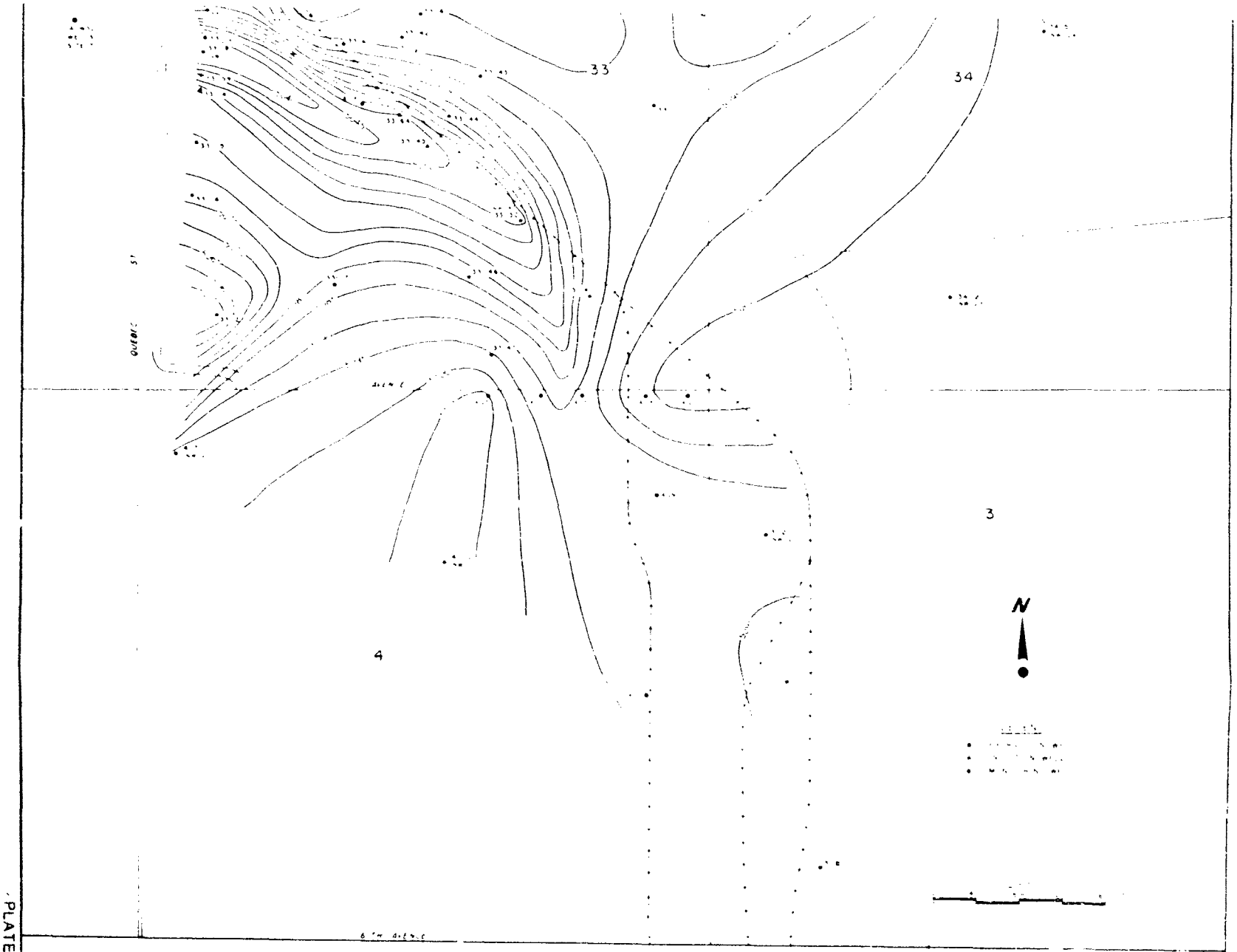
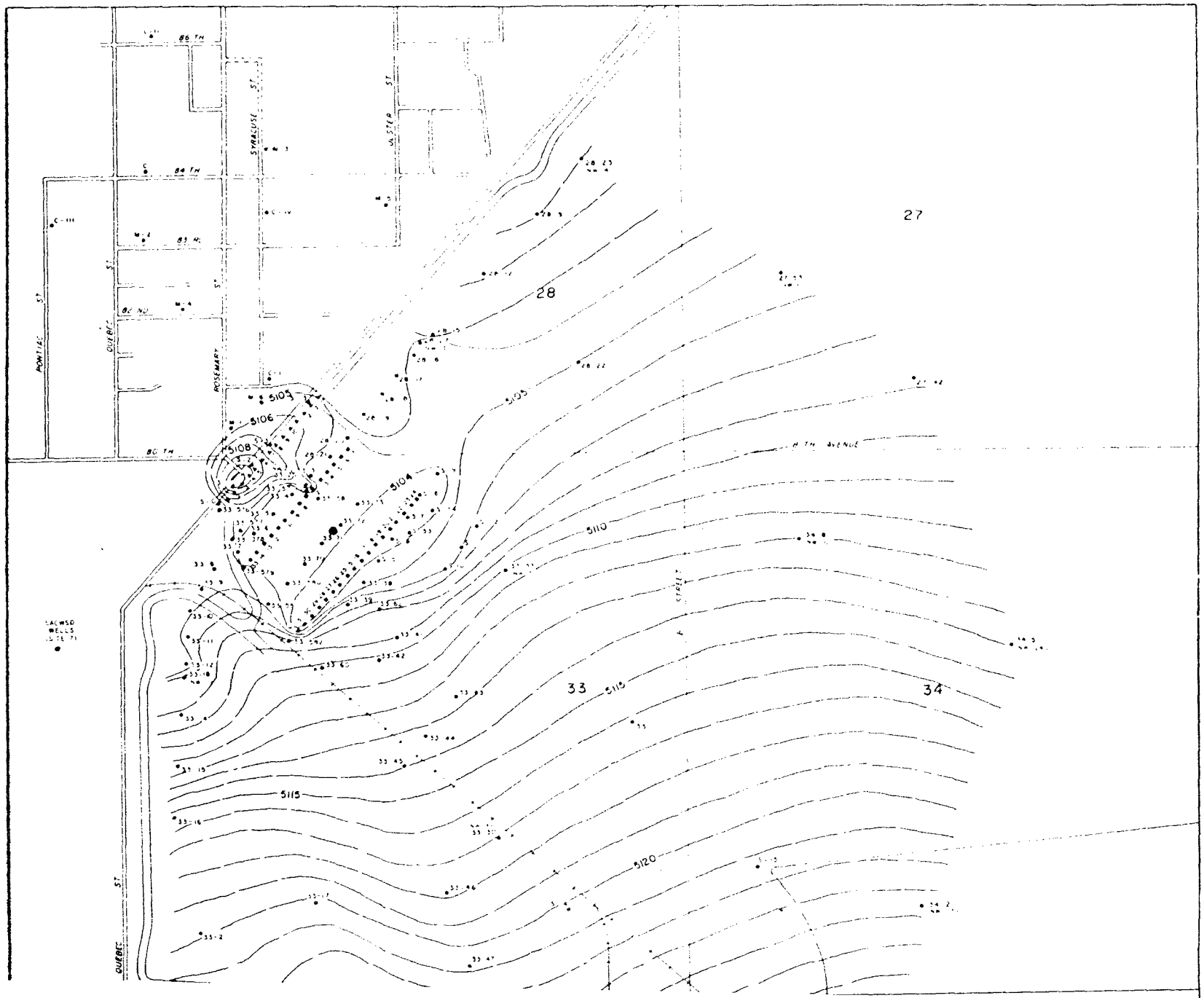
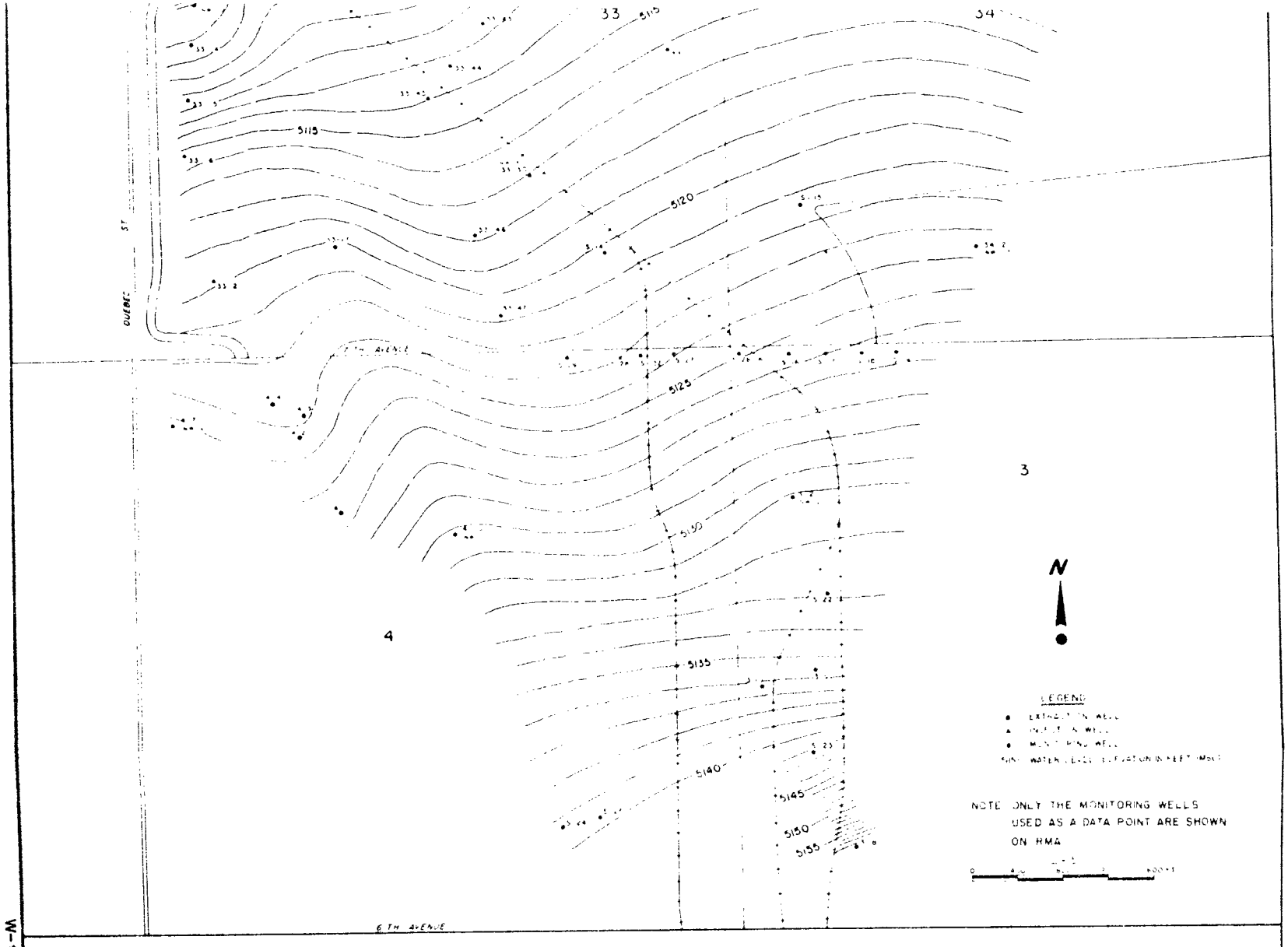


PLATE 2

PREPARED FOR
DEPARTMENT OF THE ARMY
ROCKY MOUNTAIN ARSENAL
COMMERCE CITY, COLORADO
BY

TOP OF DENVER FORMATION
IRONDALE DBCP CONTROL SYSTEM

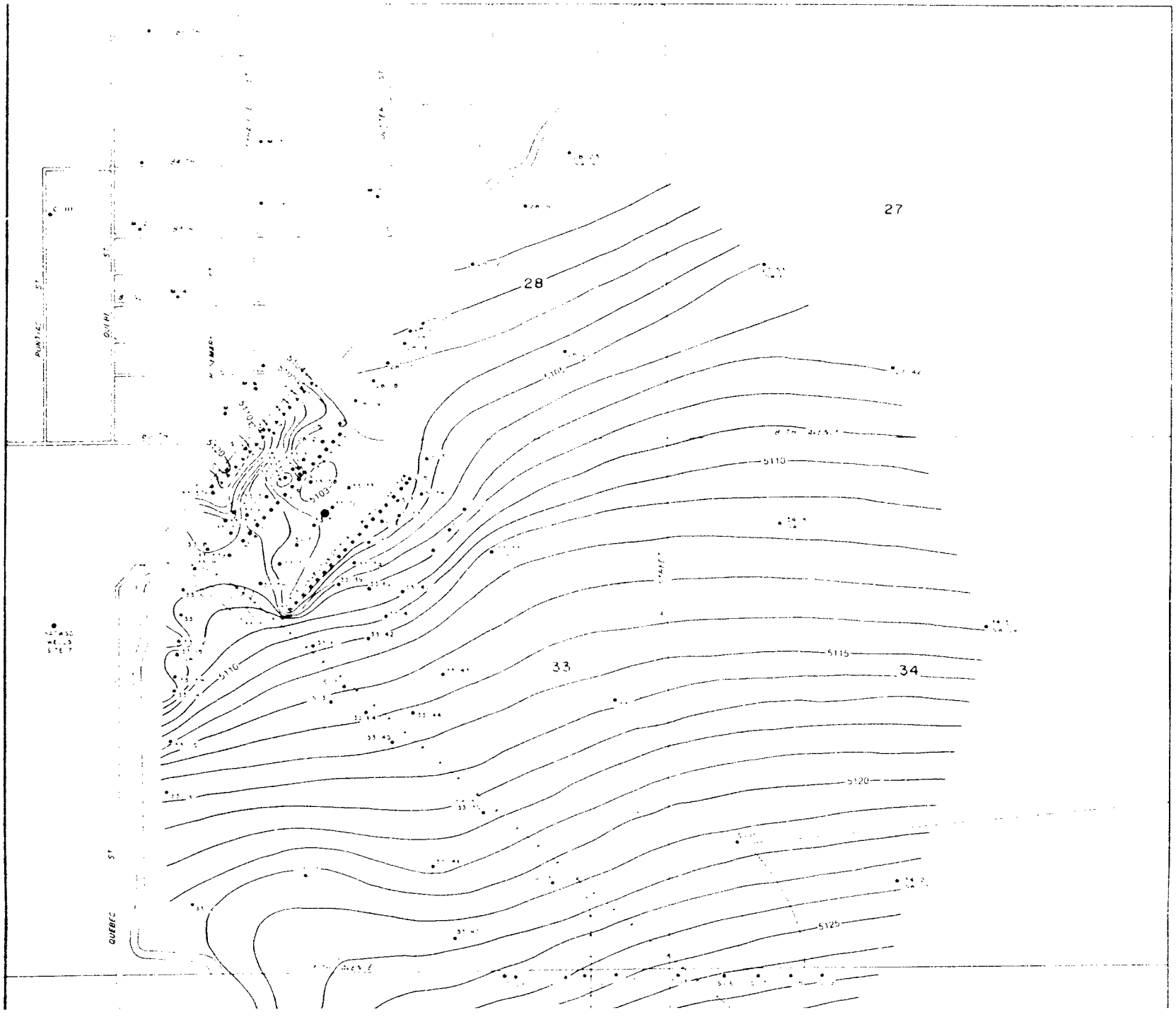

86 TH
84 TH
83 RD
80 ND
80 TH
SYRACUSE ST
ULSTER ST
PONTIAC ST
QUEBEC ST
ROSEMARY ST
27
28
33
34
5103
5104
5105
5106
5108
5110
5115
5120
STEELE
H TH AVENUE
LACWSD
WELLS
SITE 71

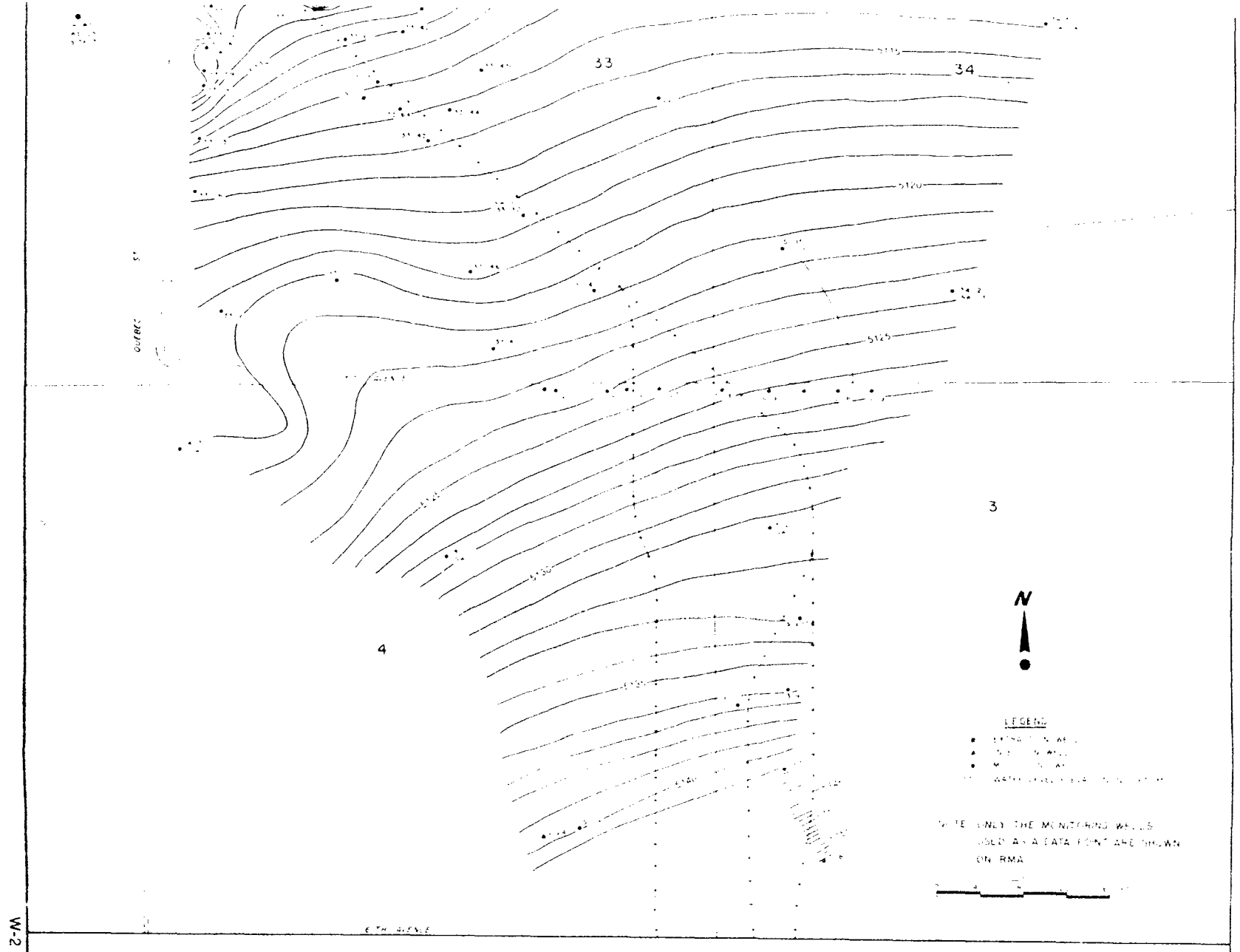


W-1

PREPARED FOR
DEPARTMENT OF THE ARMY
ROCKY MOUNTAIN ARSENAL
COMMERCE CITY, COLORADO
BY
WATERWAYS EXPERIMENT STATION

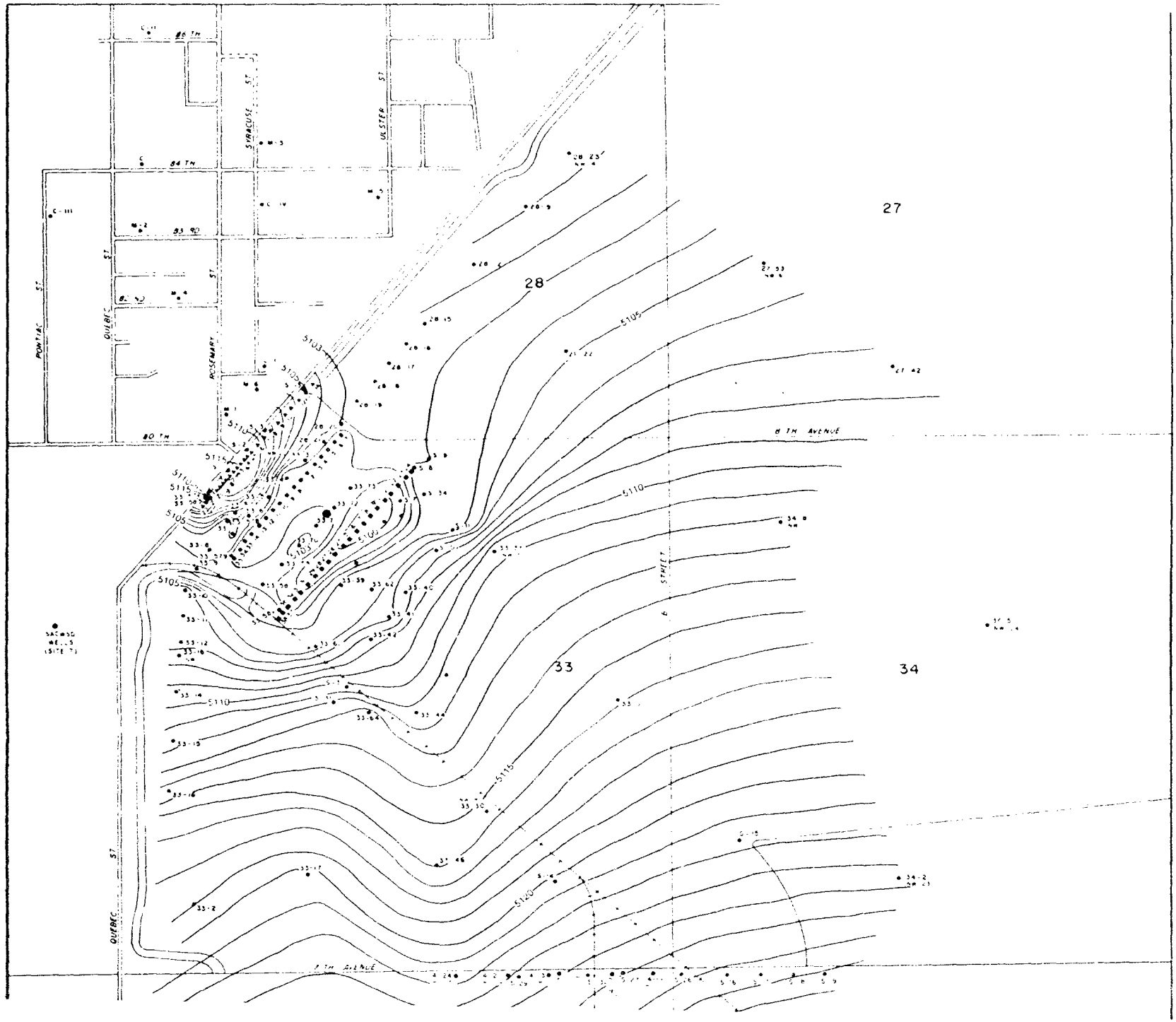
WATER LEVEL ELEVATION MAP
IRONDALE DBCP CONTROL SYSTEM
FEBRUARY 6-7, 1984

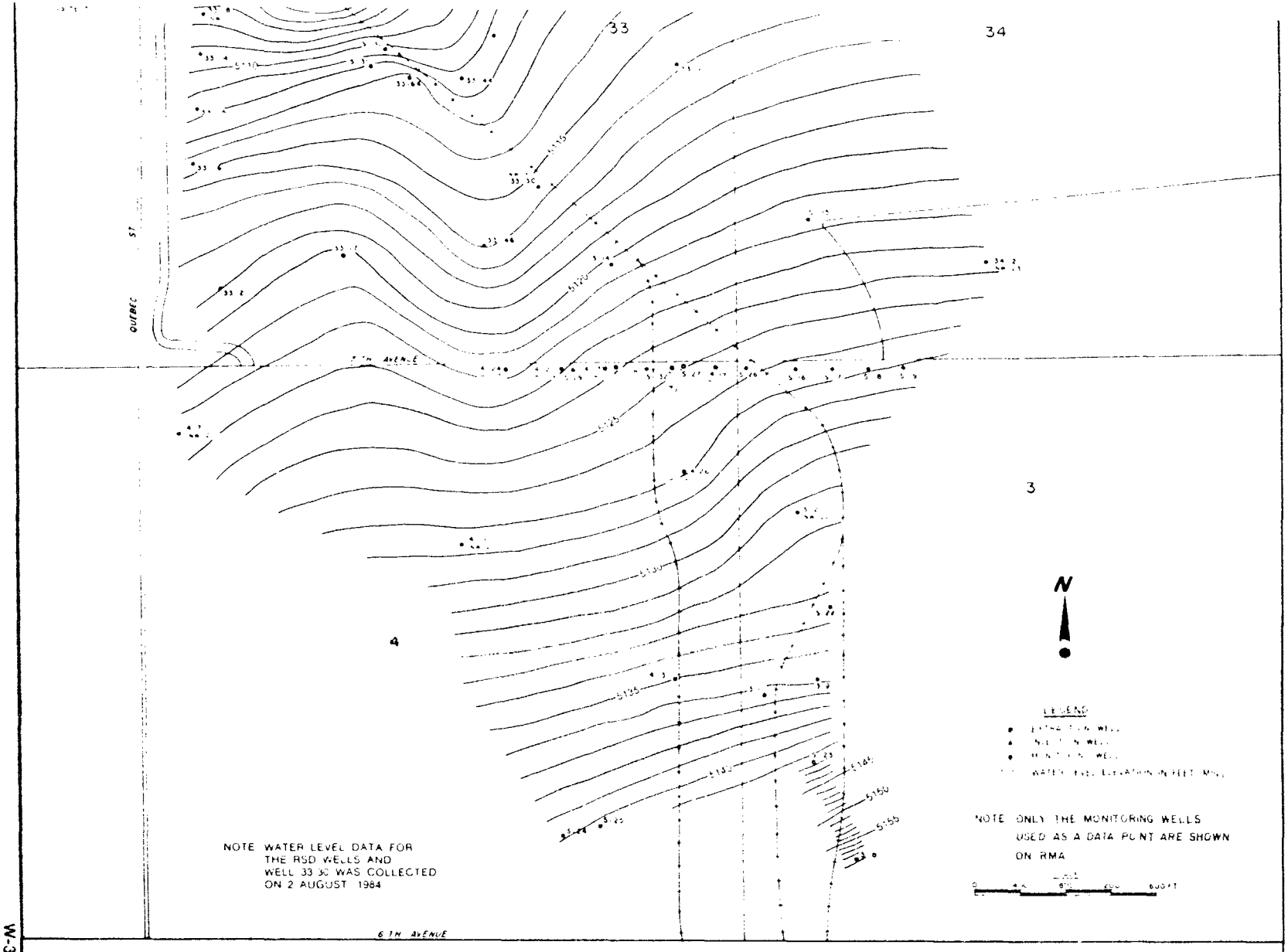

27
28
33
34
5110
5115
5120
5125
QUEBEC ST



PREPARED FOR
DEPARTMENT OF THE ARMY
ROCKY MOUNTAIN ARSENAL
COMMERCE CITY, COLORADO
BY

WATER LEVEL ELEVATION MAP
IRONDALE DBCP CONTROL SYSTEM
APRIL 3-4, 1984

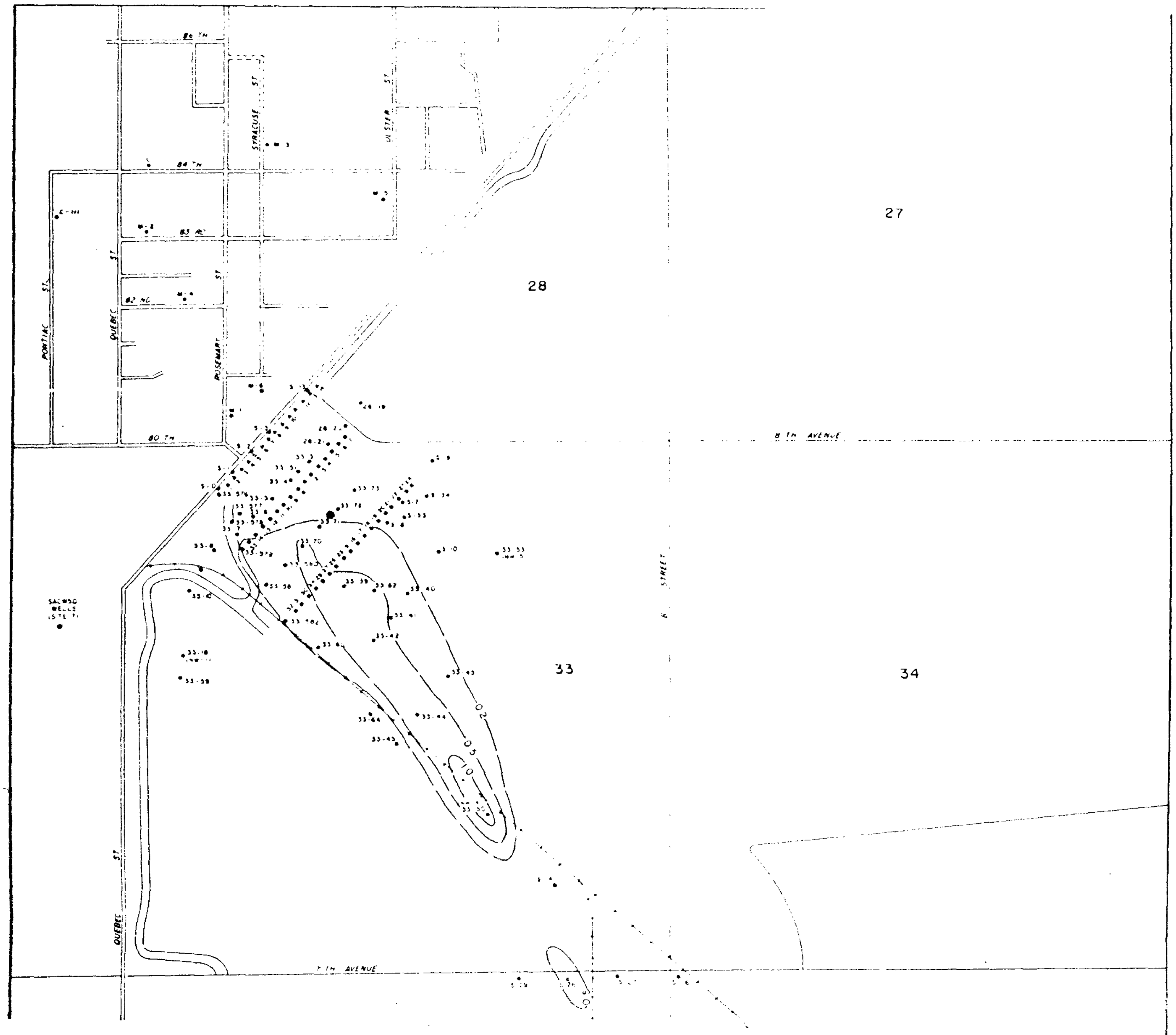

85 TH
84 TH
83 RD
80 TH
SYRACUSE ST
ULSTER ST
PONTIAC ST
QUEBEC ST
ROSEMARY ST
8 TH AVENUE
9 TH AVENUE
6 STREET
27
28
33
34
5103
5105
5110
5115
5120



M-3

PREPARED FOR
DEPARTMENT OF THE ARMY
ROCKY MOUNTAIN ARSENAL
COMMERCE CITY, COLORADO
BY
WATERWAYS EXPERIMENT STATION

WATER LEVEL ELEVATION MAP
IRONDALE DBCP CONTROL SYSTEM
JUNE 26-28, 1984


27
28
33
34
8TH AVENUE
7TH AVENUE
B STREET
80TH
84TH
83 PL
82 PL
SYRACUSE ST
ULSTER ST
ROSEMARY ST
QUEBEC ST
PONTIAC ST
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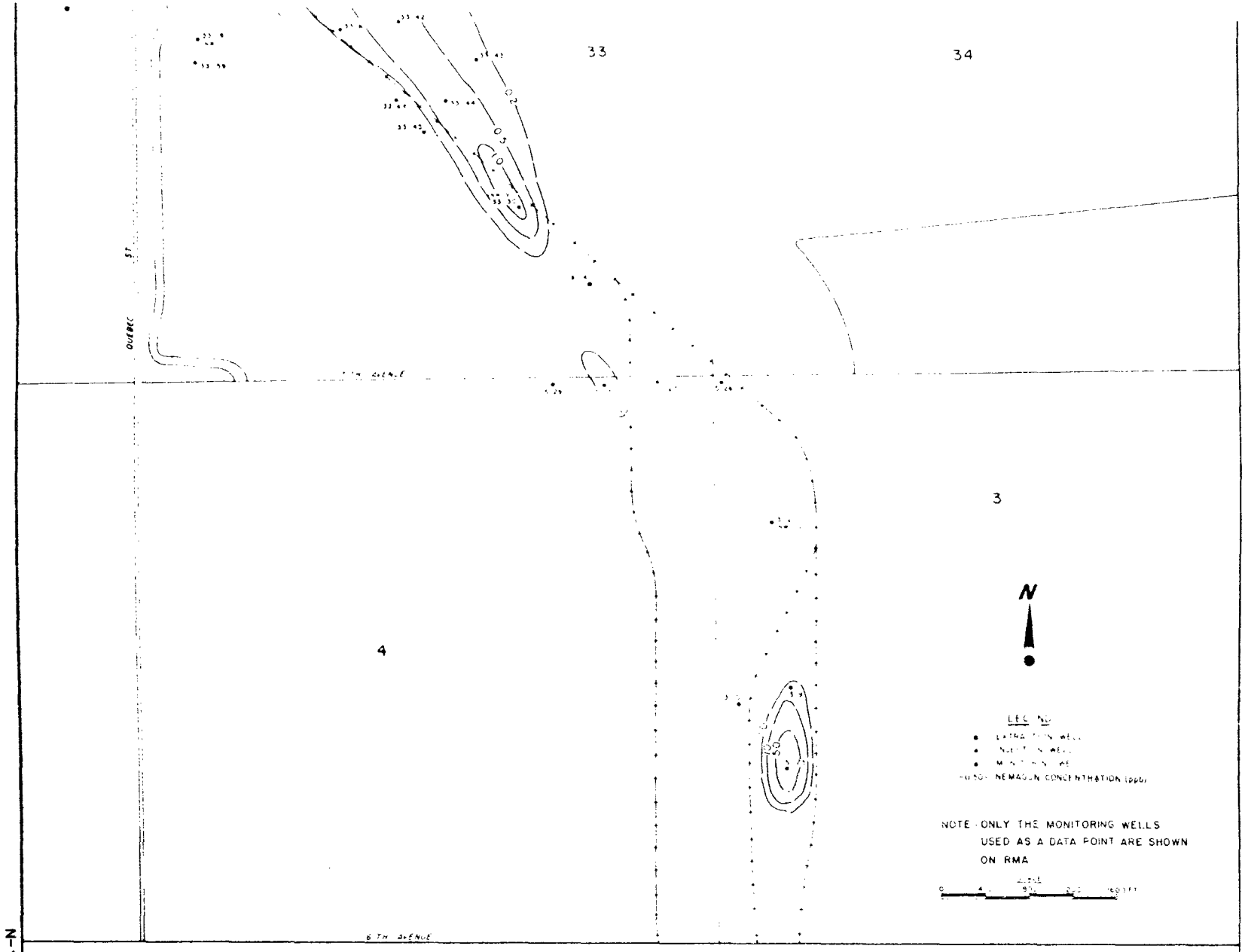
0.5
1.0



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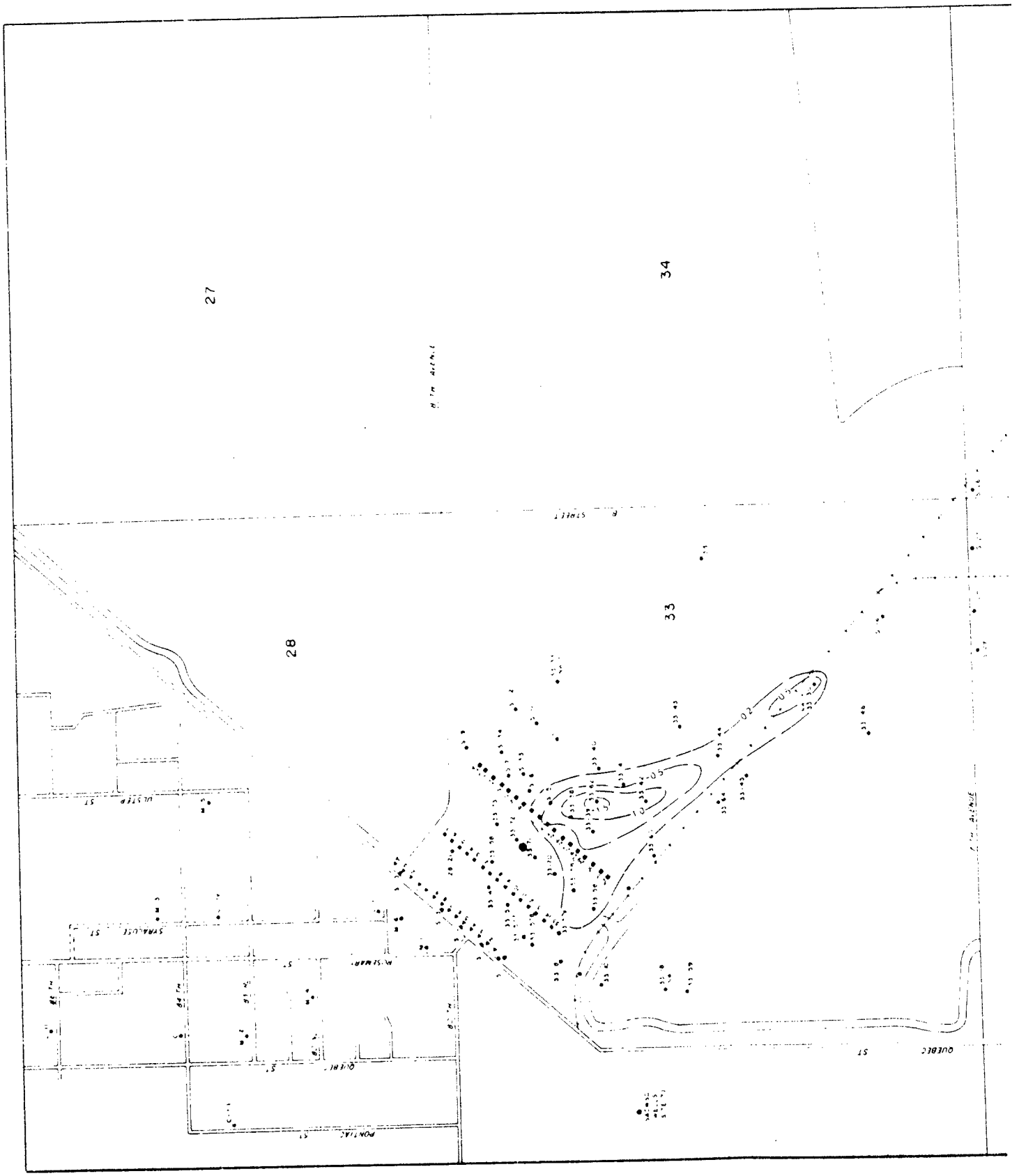
COMMERCE CITY, COLORADO
BY
WATERWAYS EXPERIMENT STATION

NEMAGON CONCENTRATION MAP
IRONDALE DBCP CONTROL SYSTEM
JANUARY 16-27, 1984


27
34
28
33
.02
.05
.1
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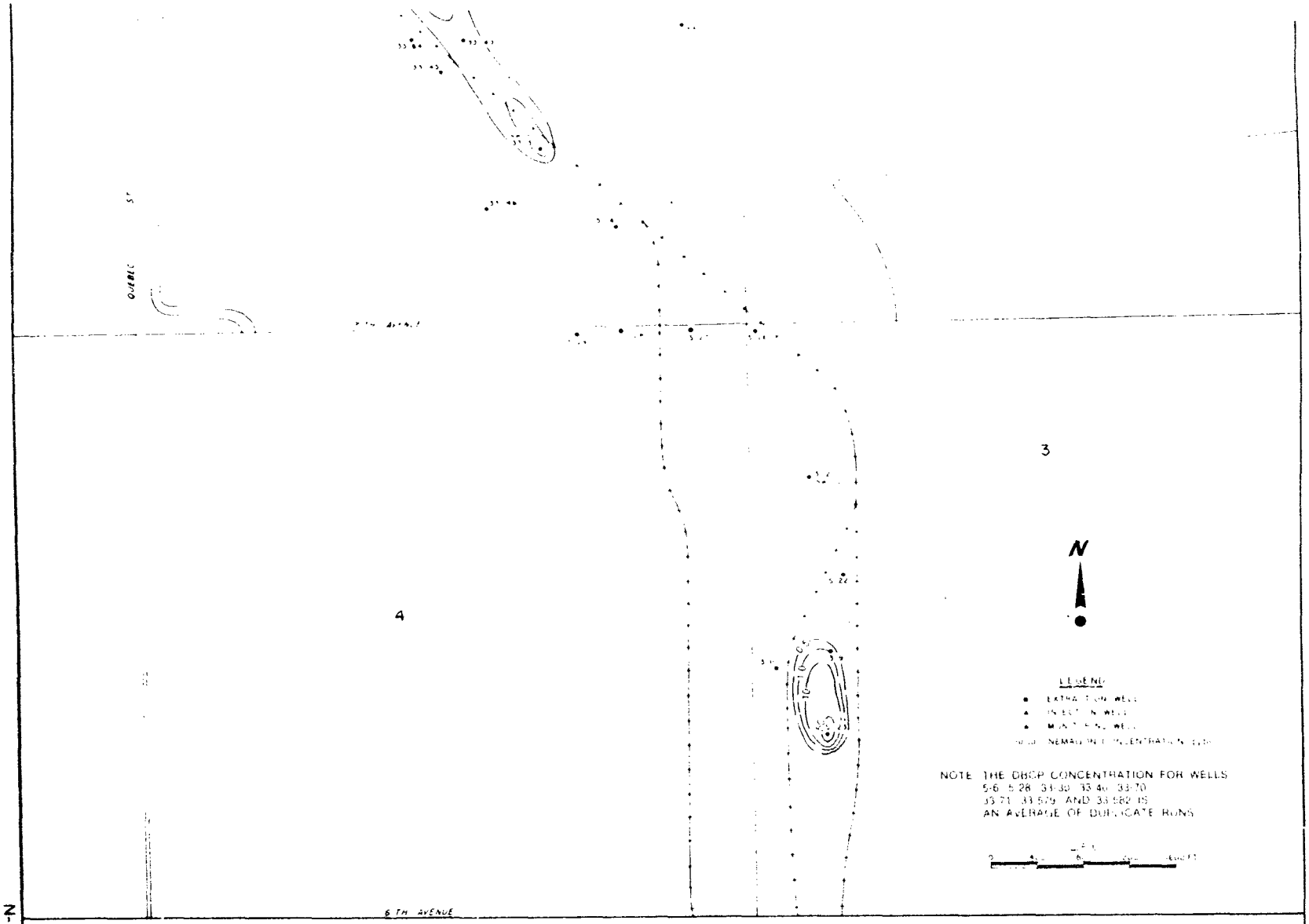
.5
1.0
QUEBEC ST



N-2

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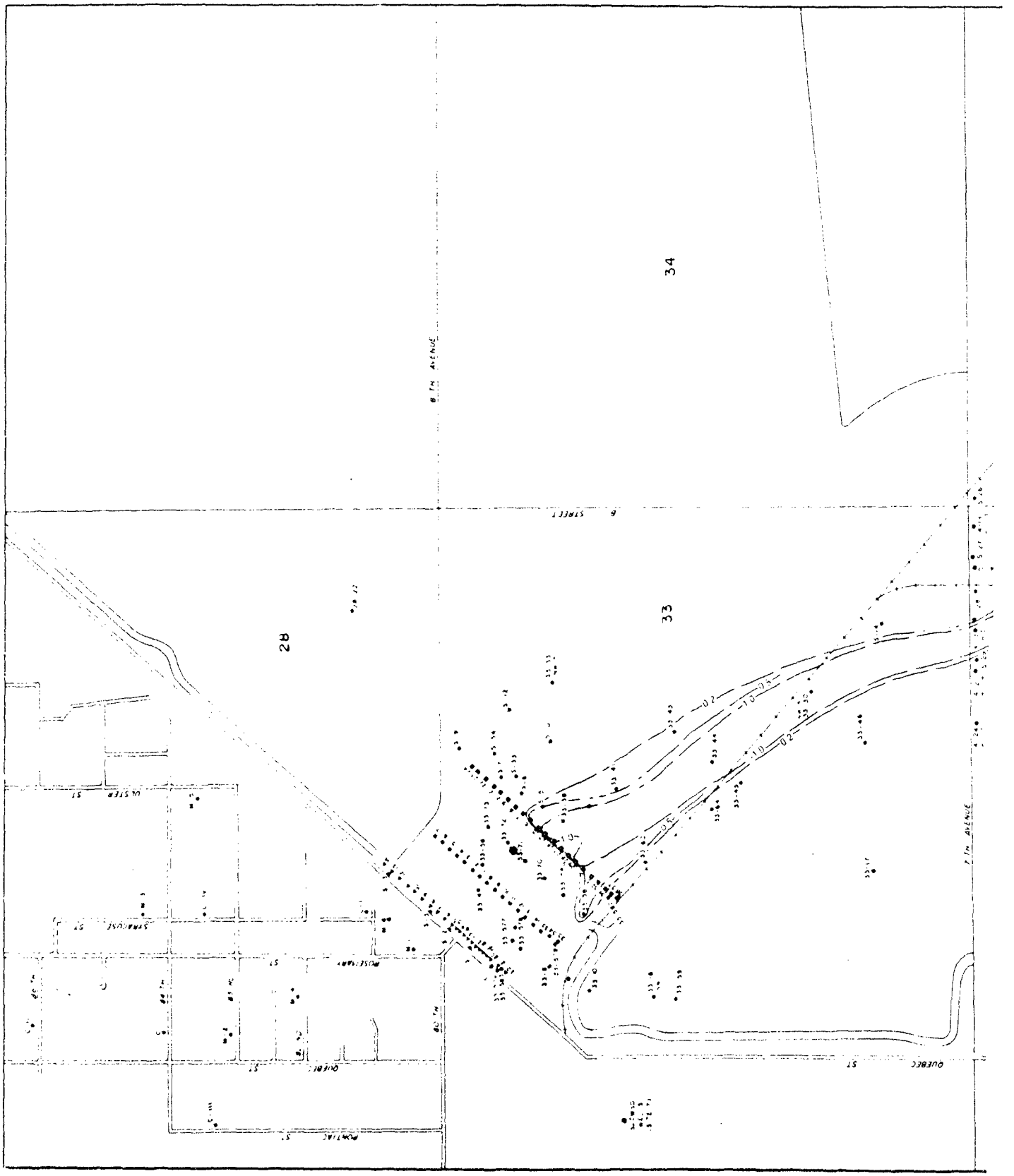
ROCKY MOUNTAIN ARSENAL
COMMERCE CITY, COLORADO
BY
WATERWAYS EXPERIMENT STATION

NEMAGON CONCENTRATION MAP
IRONDALE DBCP CONTROL SYSTEM
APRIL 9-25, 1984



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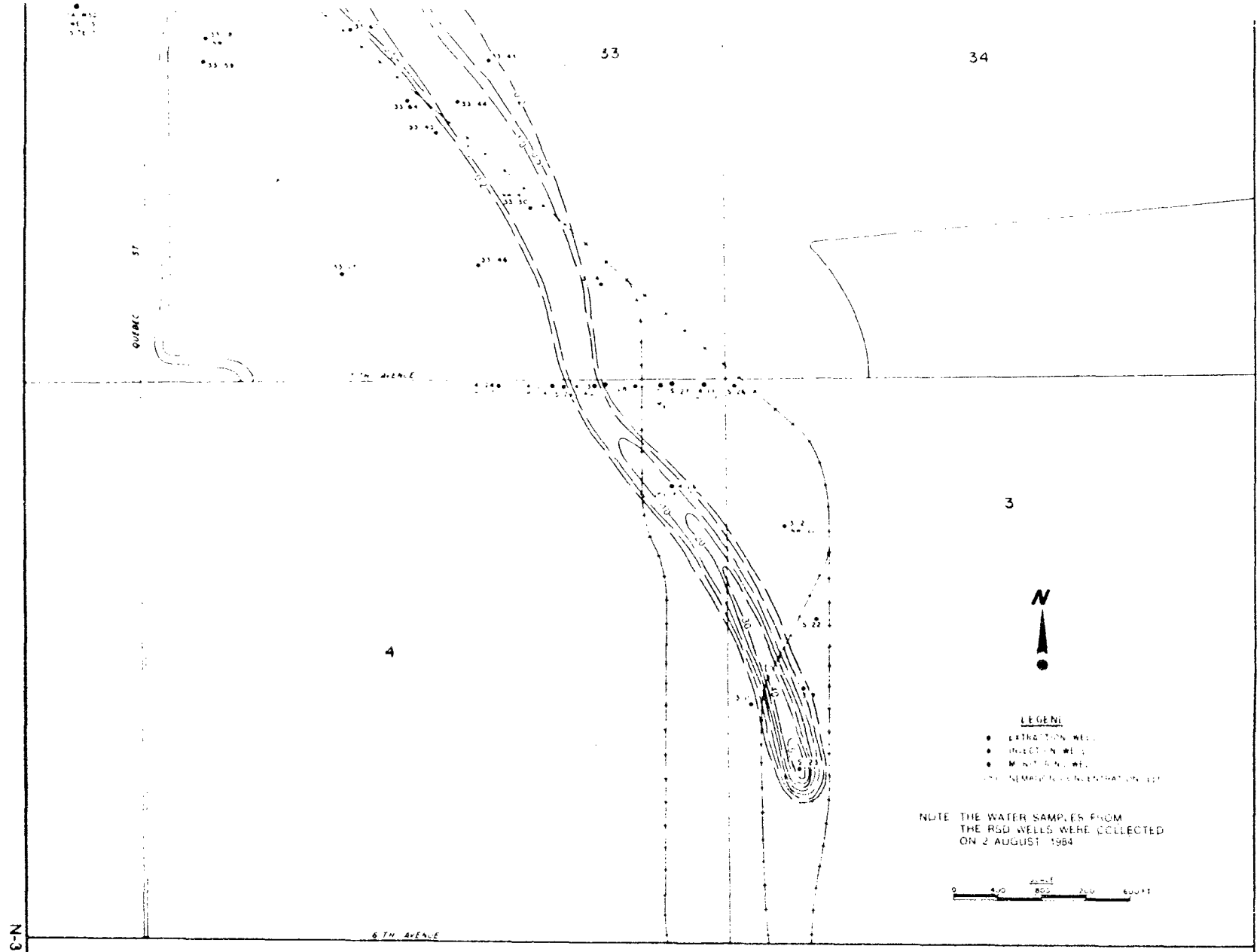

PREPARED FOR
DEPARTMENT OF THE ARMY
ROCKY MOUNTAIN ARSENAL
COMMERCE CITY, COLORADO
BY
WATERWAYS EXPERIMENT STATION

NEMAGON CONCENTRATION MAP
IRONDALE DBCP CONTROL SYSTEM
JULY 3-13, 1984

APPENDIX: ANALYTICAL DATA FROM SCC

Shell Chemical Company
A Division of Shell Oil Company

One Shell Plaza
P O Box 3671
Houston, Texas 77001

February 21, 1984

Colorado Department of Health
Waste Management Division
ATTN Mr. K. L. Waesche, Director
4210 East 11th Avenue
Denver, CO 80220

Gentlemen:

Enclosed is a copy of DBCP analysis of water samples taken from the Irondale DBCP control system from October 17, 1983 to January 27, 1984. Also included are the results of samples associated with the 360 degree plan.

Sincerely,

J. C. Dean
Manager Operations
Agricultural Chemicals
Chemical Logistics

EWS:mhw

Enclosures

c - LTC Richard W. Smith
Commander
Rocky Mountain Arsenal
Commerce City, CO 80022

Commander
Rocky Mountain Arsenal
ATTN B. L. Anderson
Building 101
Commerce City, CO 80022

bc - Denver Plant File CF 124-4
HS&E-IS (2)

IRONDALE DBCP CONTROL SYSTEM - GROUNDWATER QUALITY MONITORING DATA

I. CONTROL SYSTEM

A. Adsorbers

	DBCP, PPB						
		V - 101			V - 102		
Sample Date	Sump	Bottom	Middle	Effluent	Bottom	Middle	Effluent
10/27/83	--	--	--	BDL	--	--	BDL
11/7/83	--	--	--	BDL	--	--	BDL
11/11/83	P	BDL	BDL	BDL	BDL	BDL	BDL
12/2/83	P	BDL	BDL	--	BDL	BDL	--
12/19/83	0.23	--	BDL	BDL	--	BDL	BDL
1/25/84	0.30	--	BDL	BDL	--	BDL	BDL

B. Extraction Wells - Sampled 1/27/84

WELL I.D.	DBCP, PPB	WELL I.D.	DBCP, PPB
W-2	BDL	W-16	0.36
W-4	BDL	W-18	0.21
W-6	BDL	W-22	BDL
W-8	BDL	W-24	BDL
W-10	BDL	W-25	BDL
W-12	BDL	W-27	0.50
W-14	P	W-29	0.56
W-33	0.25	W-31	P
		W-32	P

II. ON-POST MONITORING WELLS

A. Sampled 1/16 to 1/27/84

WELL I.D.	DBCP, PPB	WELL I.D.	DBCP, PPB	WELL I.D.	DBCP, PPB
S-0	P	28-19	BDL	33-42	0.89
S-1	P	28-20	BDL	33-43	0.36
S-2	P	28-21	BDL	33-44	0.72
S-3	BDL	33-3	BDL	33-45	BDL
S-7	BDL	33-4	BDL	33-51	BDL
S-10	BDL	33-5	BDL	33-59	BDL
S-13	BDL	33-6	BDL	33-60	0.24
S-14	BDL	33-7	BDL	33-62	0.94
S-23	104	33-8	BDL	33-63	BDL
S-26	BDL	33-10	BDL	33-70	0.58
S-27	BDL	33-18	BDL	33-71	0.44
S-28	0.88	33-30	1.48	33-72	BDL
S-29	BDL	33-33	BDL	33-73	BDL
3-2	BDL	33-39	0.63		
3-9	1.10	33-40	0.22		
3-10	BDL	33-41	9.42		

B.

WELL I.D.	Sampled 11/15/83 DBCP, PPB	12/19/83 DBCP, PPB	1/16/84 DBCP, PPB
33-576	BDL	BDL	P
33-577	BDL	BDL	P
33-578	BDL	BDL	P
33-579	P	--	0.36
33-580	0.32	0.28	0.37
33-581	0.33	0.41	0.42
33-582	0.42	0.32	0.40

III. OFF POST MONITORING WELLS - SAMPLED 1/24/84

WELL I.D.	DBCP, PPB
M-1	BDL
M-2	BDL
M-3	BDL
M-4	BDL
M-5	BDL
M-6	BDL
C	BDL
C III	BDL
Boilers	0.48

NOTE: BDL = Below detection limit of 0.06 ppb.
P = Indicates presence of DBCP between 0.06 ppb limit of detectability and 0.20 ppb limit of determinability.

Shell Chemical Company
A Division of Shell Oil Company

One Shell Plaza
P O Box 3871
Houston, Texas 77001

March 26, 1984

Colorado Department of Health
Waste Management Division
ATTN Mr. K. L. Waesche, Director
4210 East 11th Avenue
Denver, CO 80220

Gentlemen:

Enclosed are analyses of samples taken from the Irondale DBCP control system in January 1984, which were not included in our letter of February 21, 1984. In addition, a review of the DBCP analyses of water samples reported in our February 21 letter suggested the need to resample some of the wells. The results of the resamples are also enclosed.

Sincerely,

J C Dean

J. C. Dean
Manager Operations
Agricultural Chemicals
Chemical Logistics

EWS:mhw

Enclosures

c - LTC Richard W. Smith
Commander
Rocky Mountain Arsenal
Commerce City, CO 80022

Commander
Rocky Mountain Arsenal
ATTN B. L. Anderson
Building 101
Commerce City, CO 80022

bc - Denver Plant File CF 124-4
C. K. Hahn/R. D. Lundahl
W. D. Shepherd/W. J. Crawford
HS&E-IS (2)

Irondale DBCP Control System
Groundwater Quality Monitoring Data

I. ON POST MONITORING WELLS

A. Sampled 1/23 to 1/25/84

Well I.D.	DBCP, ppb
S-6 (33-506)	P
S-9 (33-509)	BDL
S-33 (33-533)	P
S-34 (33-534)	BDL
33-064[a]	BDL

B. Resamples

Well I.D.	DBCP, ppb 2/17	2/21	2/24
S-0	P		
S-1		BDL	
S-2		BDL	
S-23	70.6		
S-28	0.56		
33-8[b]	46.4		BDL
33-41	0.36		
33-064	BDL		
W-31		P	
W-32		P	

a) Erroneously reported on Contract Lab data sheet as well I.D. 33-063.

b) Resampled on 2/17 because of a typographical error in the January analytical report from Contract Lab identifying the sample as Well I.D. 3-8. Sampled again on 2/24 because of the anomalous result of the 2/17 sample.

Note: BDL = Below detection limit of 0.06 ppb.
P = Indicates presence of DBCP between 0.06 ppb limit of detectability and 0.20 ppb limit of determinability.

Shell Chemical Company
A Division of Shell Oil Company

One Shell Plaza
P.O Box 3671
Houston, Texas 77001

May 15, 1984

Colorado Department of Health
Waste Management Division
ATTN: Mr. K. L. Waesche, Director
4210 East 11th Avenue
Denver, CO 80220

Gentlemen:

Enclosed is a copy of DBCP analysis of water samples taken from the Irondale DBCP control system from February 14, 1984 to April 23, 1984. Also included are the results of samples associated with the 180 degree plan.

Sincerely,

For E. W. Smith

J. C. Dean
Manager Operations
Agricultural Chemicals
Chemical Logistics

EWS:mhw

Enclosures

c - LTC Richard W. Smith
Rocky Mountain Arsenal
Commerce City, CO 80022

Commander
Rocky Mountain Arsenal
ATTN: B. L. Anderson
Building 101
Commerce City, CO 80022

bc - Denver Plant File CF 124-4
HS&E IS(2)

IRONDALE DBCP CONTROL SYSTEM -
GROUNDWATER QUALITY MONITORING DATA

I. CONTROL SYSTEM

A. Adsorbers

	DBCP, PPB						
		V - 101			V - 102		
		Middle			Middle		
Sample Date	Sump	1 Foot	5 Feet	Effluent	1 Foot	5 Feet	Effluent
2/14/84	--	--	--	BDL	--	--	BDL
2/27/84	0.25	P	P	BDL	BDL	BDL	BDL
3/12/84	--	BDL	BDL	BDL	BDL	BDL	BDL
3/26/84	P	BDL	BDL	BDL	BDL	BDL	BDL
4/9/84	0.28	--	--	BDL	--	--	BDL
4/23/84	P	BDL	BDL	BDL	BDL	BDL	BDL

B. Extraction Wells - Sampled 4/9 to 4/25/84

WELL I.D.	DBCP, PPB	WELL I.D.	DBCP, PPB
W-2	BDL	W-16	0.89
W-4	BDL	W-18	0.28
W-6	BDL	W-22	BDL
W-8	BDL	W-24	BDL
W-10	BDL	W-25	0.45
W-12	BDL	W-27	0.50
W-14	BDL	W-29	0.33
W-33	BDL	W-31	BDL
		W-32	BDL

II. ON-POST MONITORING WELLS

A. Sampled 4/9 to 4/25/84

WELL I.D.	DBCP, PPB	WELL I.D.	DBCP, PPB	WELL I.D.	DBCP, PPB
S-0	BDL	S-33	P	33-42	1.31
S-1	BDL	S-34	BDL	33-43	P
S-2	BDL	3-2	BDL	33-44	*
S-3	BDL	3-9	0.82	33-45	BDL
S-6	P	3-10	BDL	33-46	BDL
S-7	BDL	28-21	BDL	33-59	BDL
S-9	BDL	33-4	BDL	33-60	BDL
S-10	BDL	33-8	BDL	33-62	1.57
S-12	BDL	33-10	BDL	33-64	BDL
S-13	BDL	33-18	DRY	33-70	P
S-14	BDL	33-19	BDL	33-71	P
S-23	*	33-20	BDL	33-72	BDL
S-26	P	33-30	0.52	33-73	BDL
S-27	BDL	33-33	BDL		
S-28	BDL	33-39	0.65		
S-29	BDL	33-40	0.17		
S-30	DRY	33-41	0.49		

* IN PROGRESS

B. Sampled 4/9 to 4/25/84

WELL I.D.	DBCP, PPB
33-576	BDL
33-577	BDL
33-578	BDL
33-579	P
33-580	0.25
33-581	0.27
33-582	P

III. OFF POST MONITORING WELLS - SAMPLED 4/25/84

WELL I.D.	DBCP, PPB
M-1	BDL
M-2	BDL
M-3	BDL
M-4	BDL
M-5	BDL
M-6	BDL
C	BDL
C III	BDL
Bollers	0.48

NOTE: BDL = below detection limit of 0.06 ppb.
P = Indicates presence of DBCP between 0.06 ppb limit of detectability and 0.20 ppb limit of determinability.

Shell Chemical Company
A Division of Shell Oil Company

One Shell Plaza
P.O. Box 3871
Houston, Texas 77001

August 22, 1984

Colorado Department of Health
Waste Management Division
ATTN: Mr. K. L. Waesche, Director
4210 East 11th Avenue
Denver, CO 80220

Gentlemen:

Enclosed is a copy of DBCP analysis of water samples taken from the Irondale DBCP control system from May 18, 1984 to July 30, 1984. Also included are the results of samples associated with the 360 degree plan.

Sincerely,

J C Dean

J. C. Dean
Manager Operations
Agricultural Chemicals

EWS:mhw

Enclosures

c - LTC Craig M. Dexter
Rocky Mountain Arsenal
Commerce City, CO 80022

Commander
Rocky Mountain Arsenal
ATTN: B. L. Anderson
Building 101
Commerce City, CO 80022

BRHN8423518

IRONDALE DBCP CONTROL SYSTEM - GROUNDWATER QUALITY MONITORING DATA

I. CONTROL SYSTEM

A. Adsorbers

DBCP

Sample Date	V - 101 Influent	V - 101 Middle 1 Foot	V - 101 Middle 5 Feet	V - 101 Effluent	V - 102 Influent	V - 102 Middle 1 Foot	V - 102 Middle 5 Feet	V - 102 Effluent
5/18/84	P	--	--	BDL	P	--	--	BDL
5/29/84	P	BDL	BDL	BDL	0.26	BDL	P	BDL
6/11/84	0.25	--	--	BDL	P	--	--	P
6/18/84	--	--	--	--	--	--	--	BDL
6/25/84	P	--	BDL	BDL	P	BDL	BDL	BDL
7/9/84	0.23	--	--	BDL	P	--	--	BDL
7/23/84	0.23	--	BDL	BDL	P	BDL	P	BDL
7/30/84	--	--	--	--	--	--	--	BDL

B. Extraction Wells - Sampled 7/3 to 7/25/84

WELL I.D.	DBCP, PPB	WELL I.D.	DBCP, PPB
W-2	BDL	W-16	0.61
W-4	BDL	W-18	BDL
W-6	BDL	W-22	BDL
W-8	BDL	W-24	BDL
W-10	BDL	W-25	1.60
W-12	BDL	W-27	0.55
W-14	BDL	W-29	1.08
W-33	BDL	W-31	0.55
W-34	BDL[a] BDL	W-32	0.77
W-35	BDL[a] BDL	W-36	BDL[a] 0.21
		W-37	BDL[b] P
		W-38	BDL[a] P

BRHN8423510

II. ON-POST MONITORING WELLS

A. Sampled 7/3 to 7/13/84

WELL I.D.	DBCP, PPB	WELL I.D.	DBCP, PPB	WELL I.D.	DBCP, PPB
S-0	BDL	S-33	BDL	33-42	DRY
S-1	BDL	S-34	BDL	33-43	0.23
S-2	BDL	3-2	BDL	33-44	0.30[c] 1.31
S-3	BDL	3-9	0.72	33-45	BDL
S-6	BDL	3-10	BDL	33-46	BDL
S-7	BDL	28-21	BDL	33-59	BDL
S-9	BDL	33-4	BDL	33-60	BDL
S-10	BDL	33-8	BDL	33-62	DRY
S-12	BDL	33-10	BDL	33-64	BDL
S-13	BDL	33-18	DRY	33-70	BDL
S-14	BDL	33-19	BDL	33-71	BDL
S-23	61[c] 58	33-20	BDL	33-72	BDL
S-26	BDL	33-30	1.48	33-73	BDL
S-27	BDL	33-33	BDL		
S-28	BDL	33-39	DRY		
S-29	BDL	33-40	DRY		
S-30	DRY	33-41	0.38		

B. Sampled 7/3 to 7/13/84

WELL I.D.	DBCP, PPB
33-576	BDL
33-577	BDL
33-578	BDL
33-579	BDL
33-580	P
33-581	0.51
33-582	P
33-583[d]	BDL

III. OFF POST MONITORING WELLS - M-6 Sampled 7/12; all others sampled 7/23/84

WELL I.D.	DBCP, PPB
M-1	BDL
M-2	BDL
M-3	BDL
M-4	BDL
M-5	BDL
M-6	BDL
C	BDL
C III	BDL
Boilers	0.44

a) New extraction wells, sampled 5/18/84.
b) New extraction well, sampled 5/29/84.
c) Results from sample taken 5/14/84.
d) New monitoring well, sampled 7/3/84.

NOTE: BDL = Below detection limit of 0.06 ppb.
P = Indicates presence of DBCP between 0.06 ppb limit of detectability and 0.20 ppb limit of determinability.